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(54) **METHODS AND APPARATUS FOR LUMINAL STENTING**

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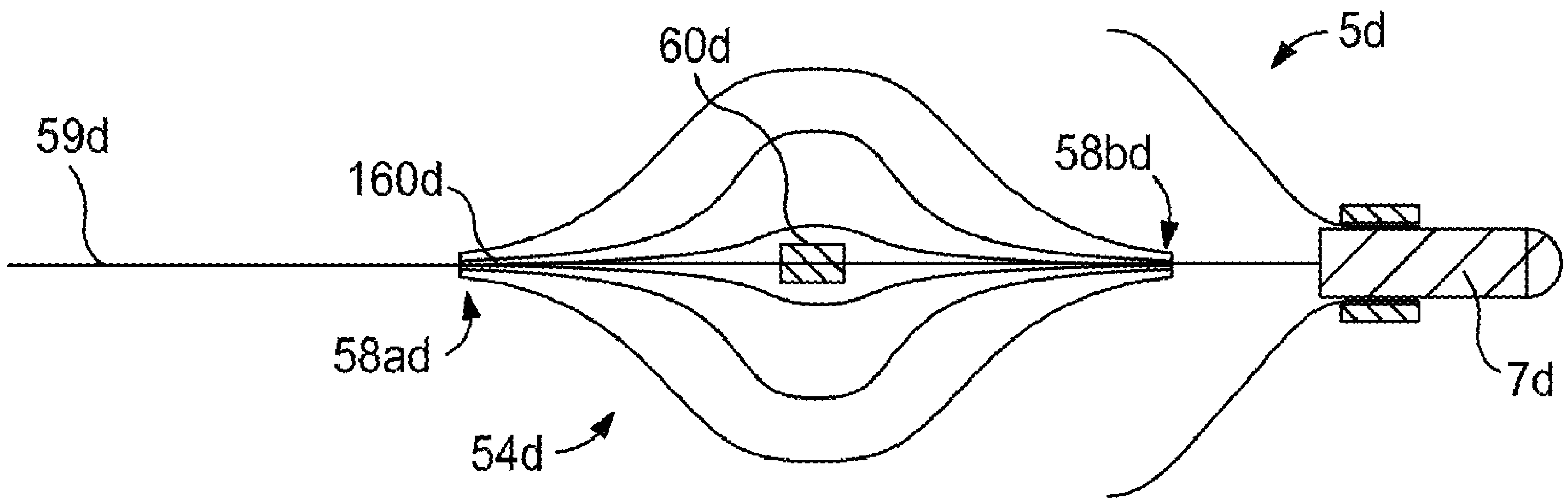
(57) **ABSTRACT**

A stent delivery system can include a core wire and a self-expanding member disposed along the core wire. The self-expanding member can be used to facilitate expansion of a stent or other implantable device within the vasculature of a patient. The self-expanding member can include first and second end portions that are each axially slidable along the core wire and be able to expand from a collapsed configuration to an expanded configuration upon axial convergence of the first and second end portions.

18 Claims, 6 Drawing Sheets



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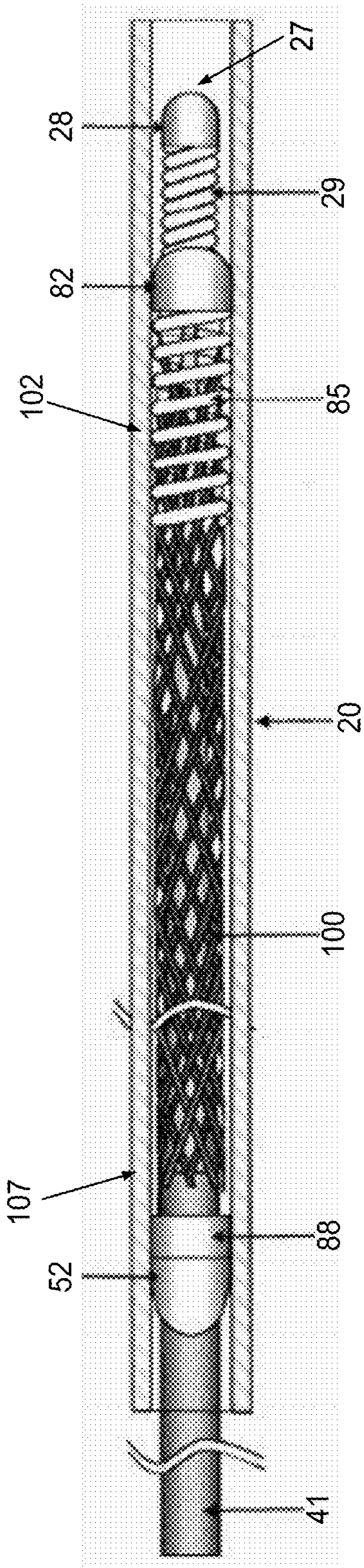


FIG. 1

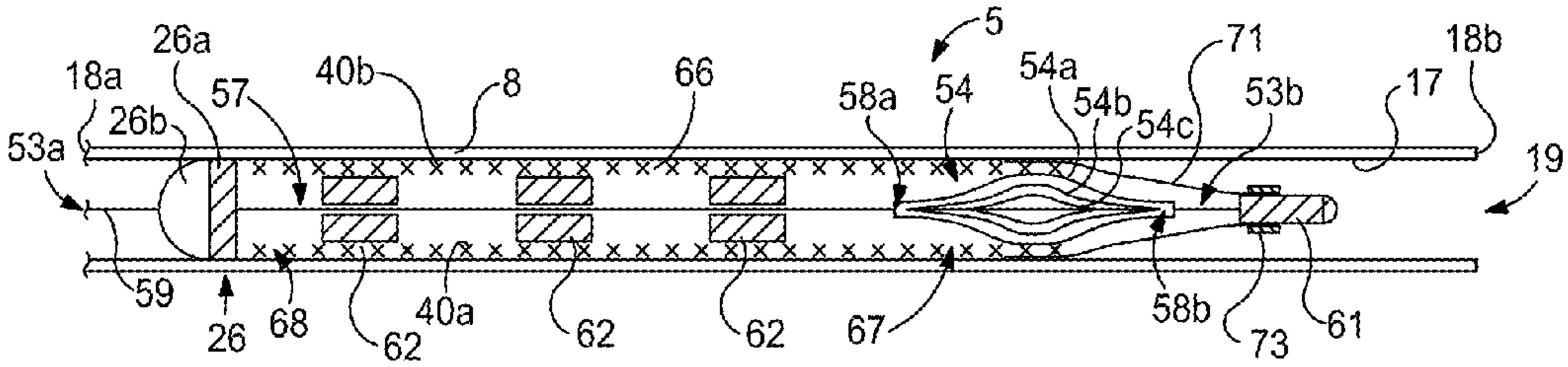


FIG. 2

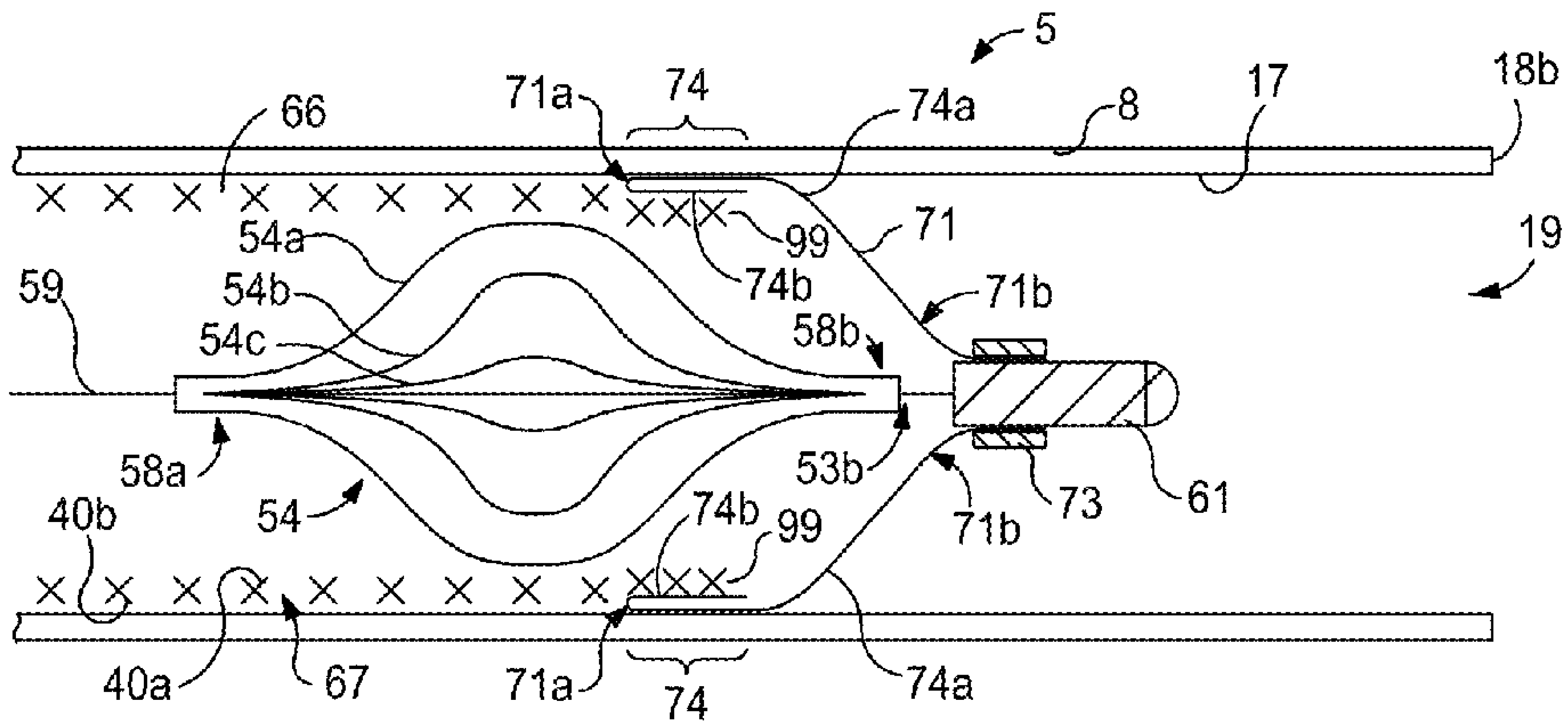


FIG. 3A

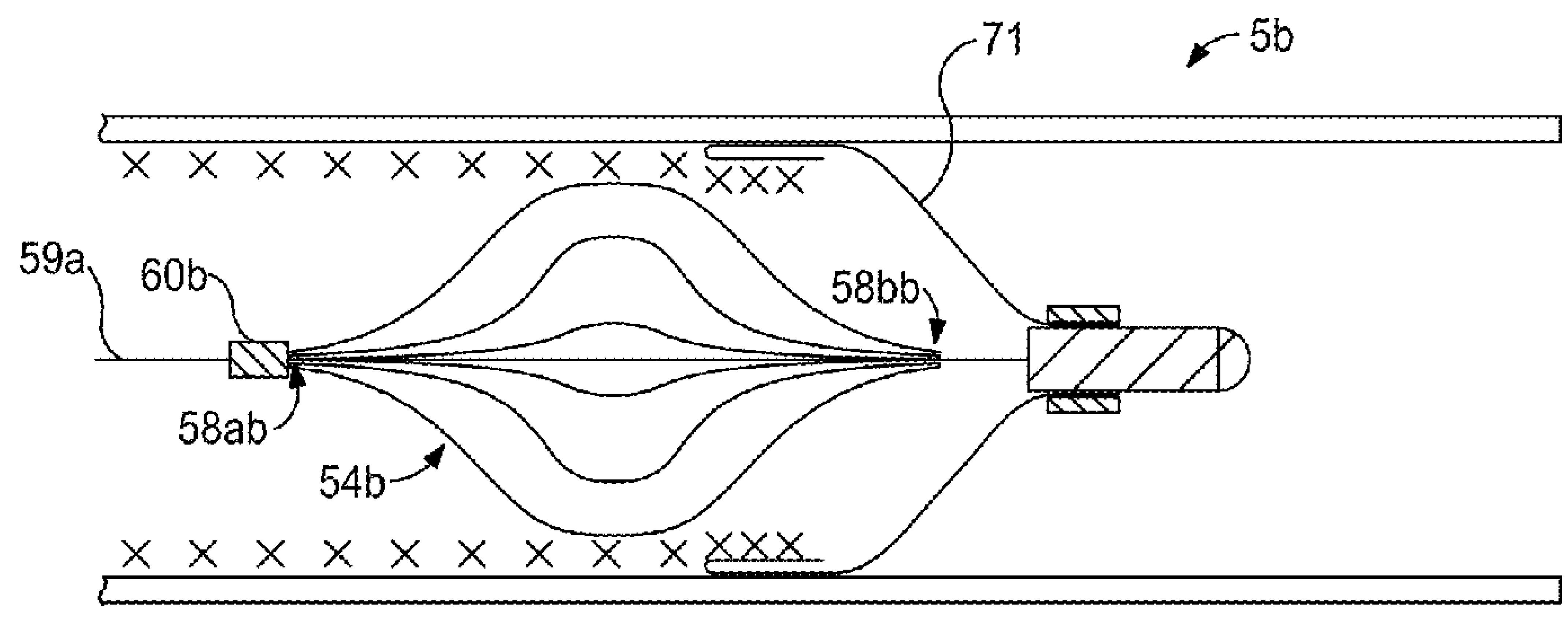


FIG. 3B

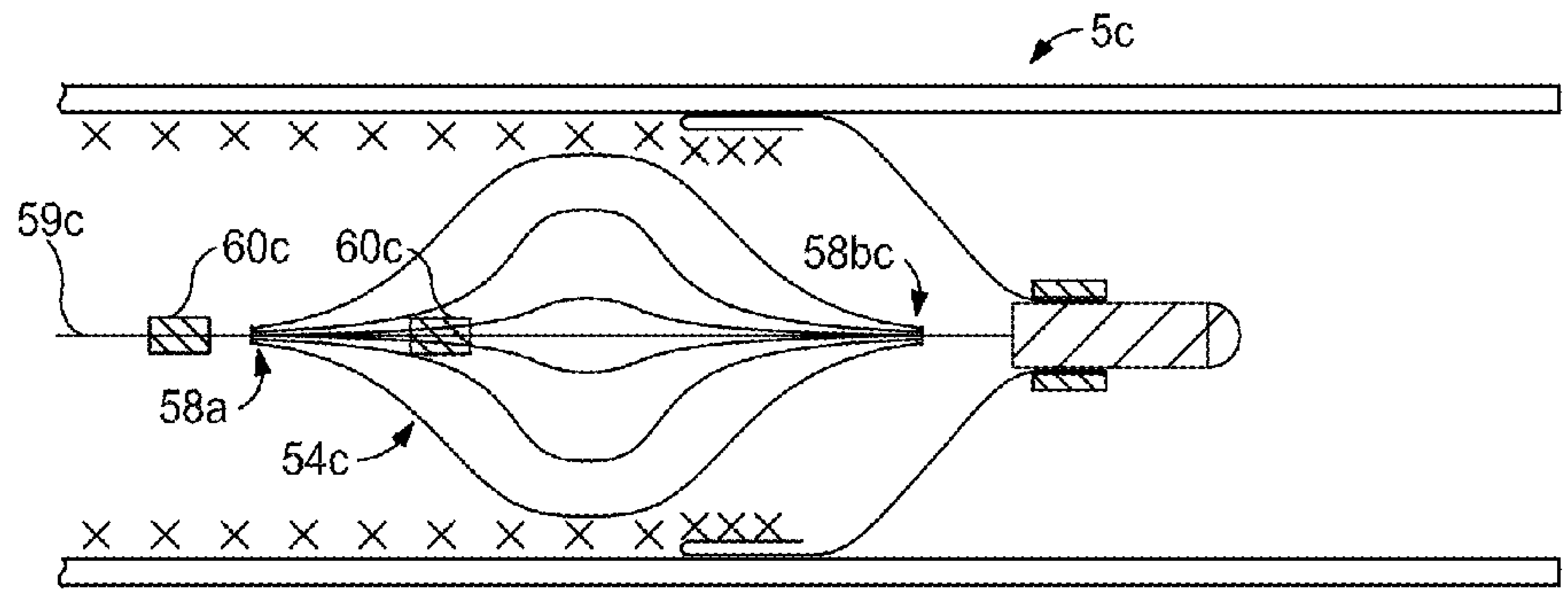


FIG. 3C

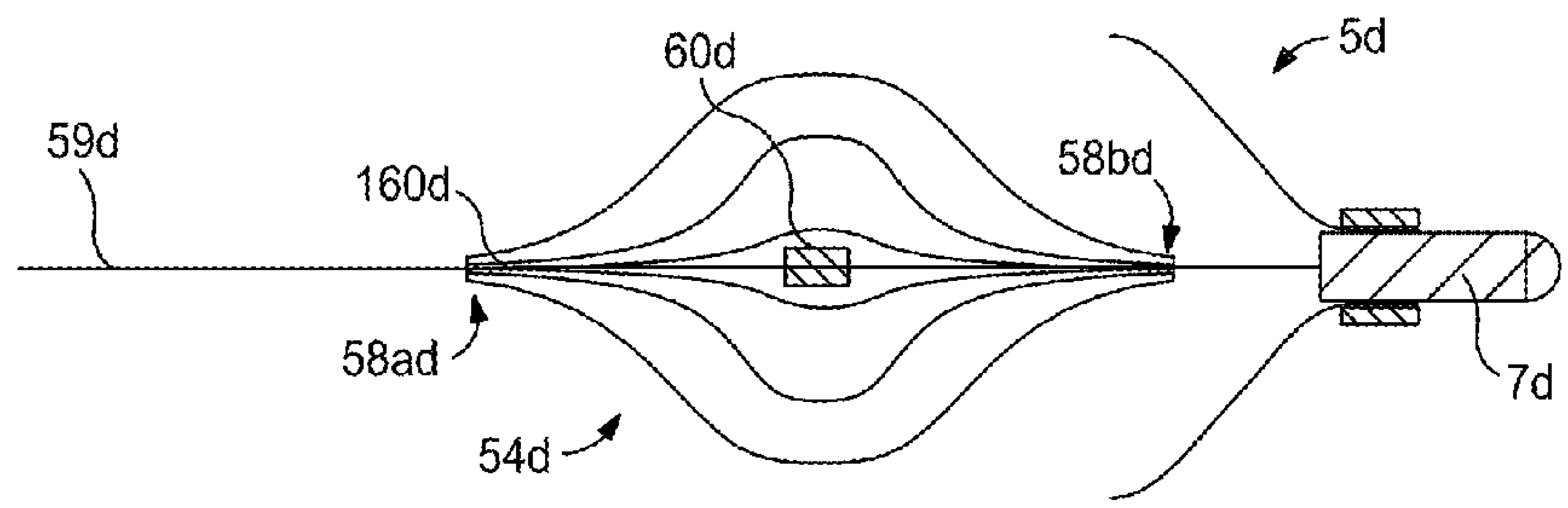


FIG. 3D

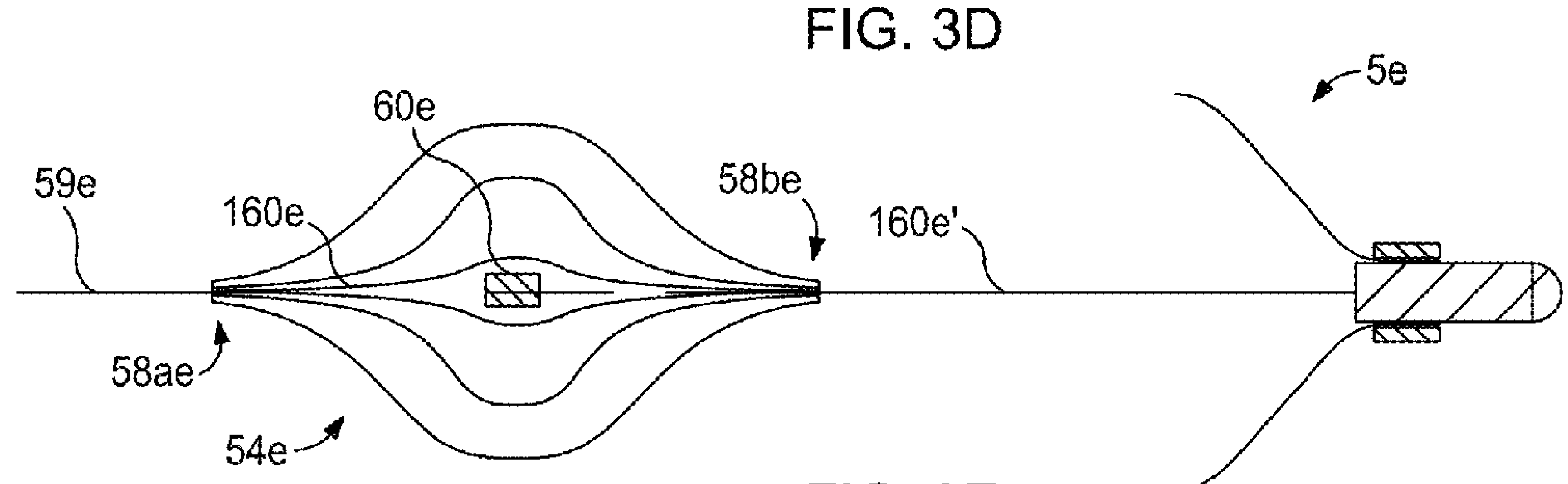


FIG. 3E

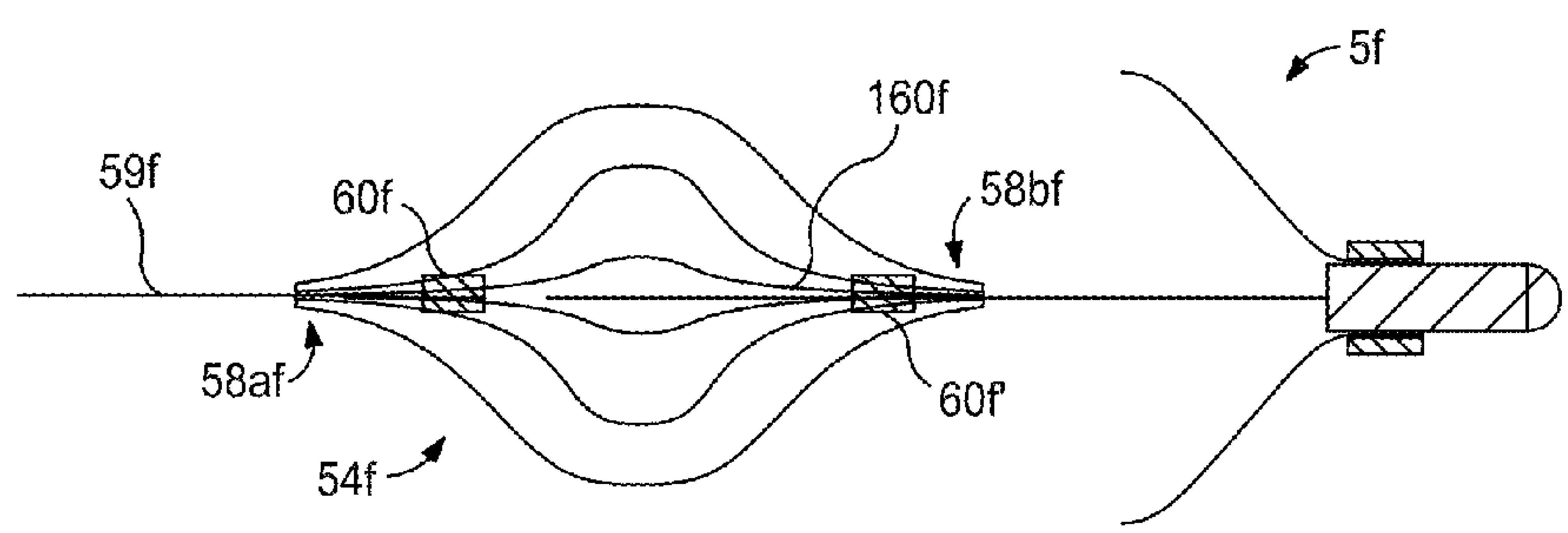


FIG. 3F

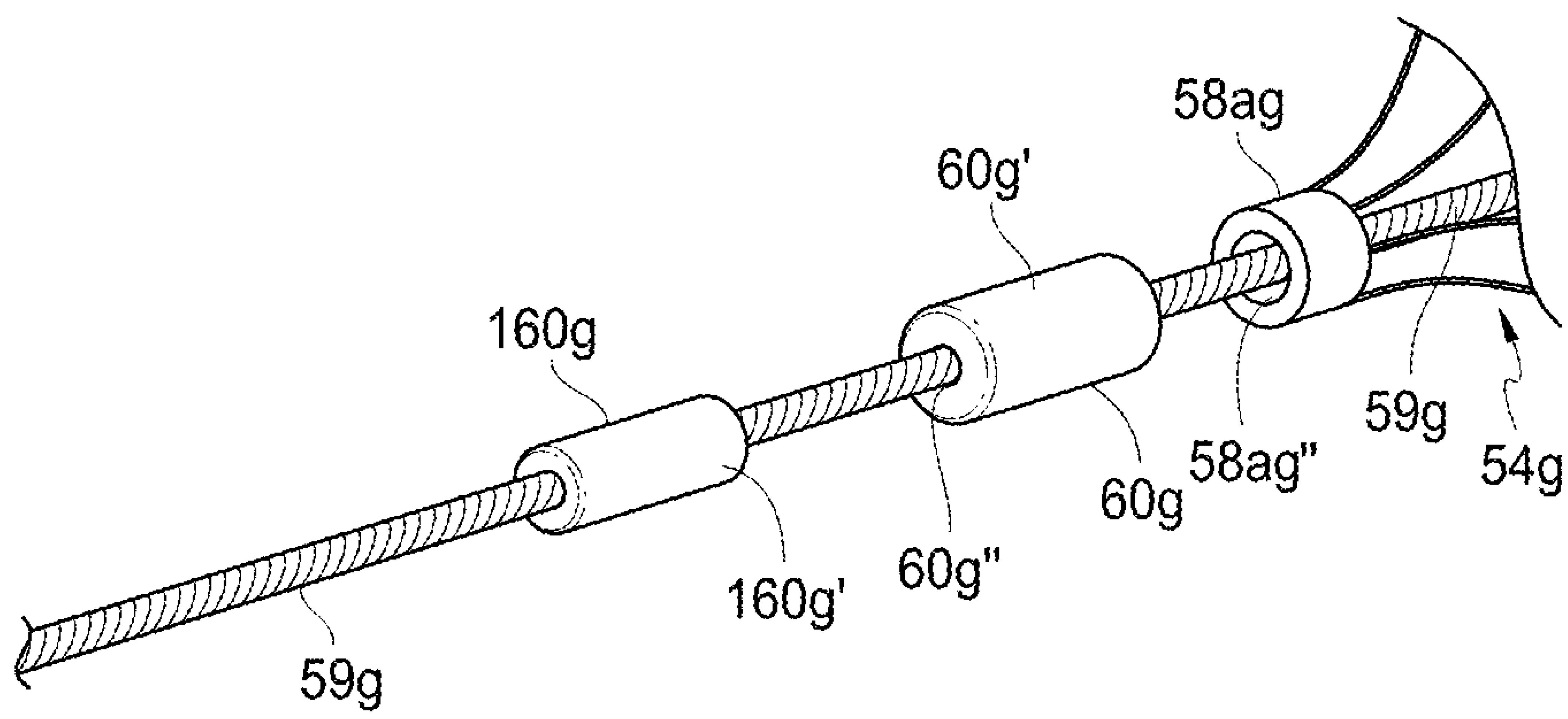
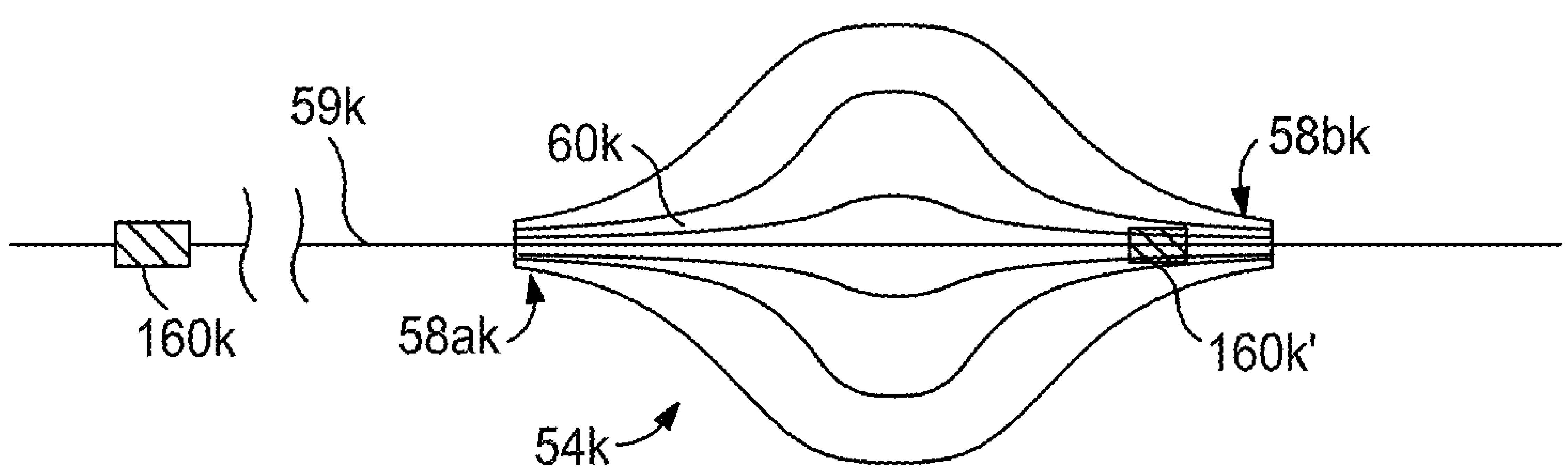

58ag
60g'
160g
58ag"
59g
54g
60g
160g'
60g"
59g

FIG. 3G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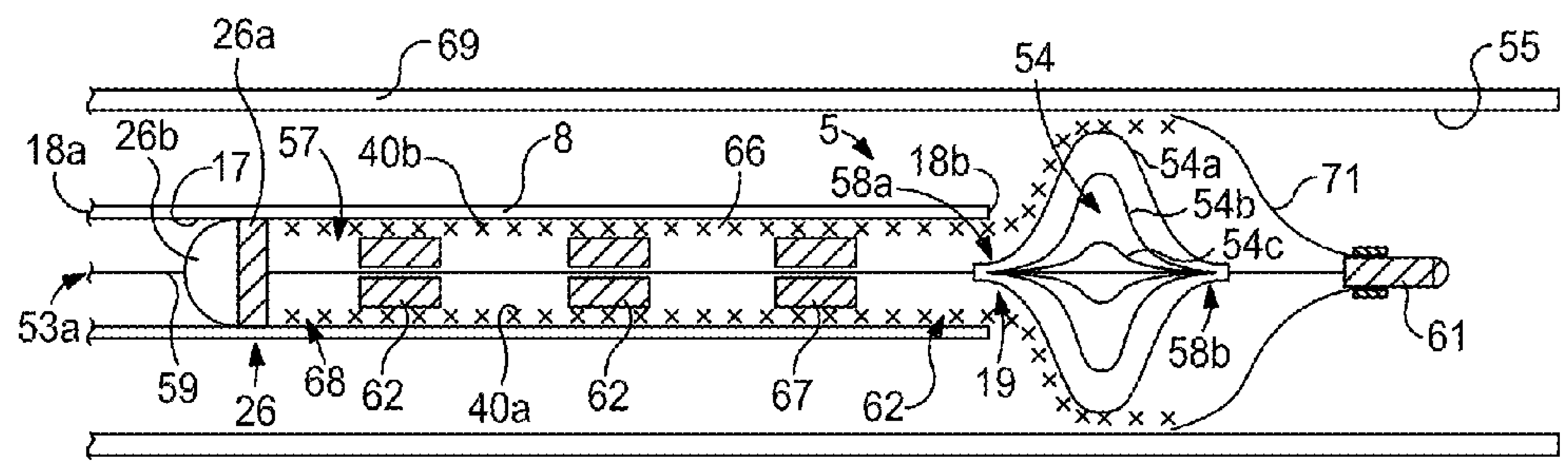
160k'
54k

FIG. 4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54
18a
26b
17
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40b
8
66
5
18b
58a
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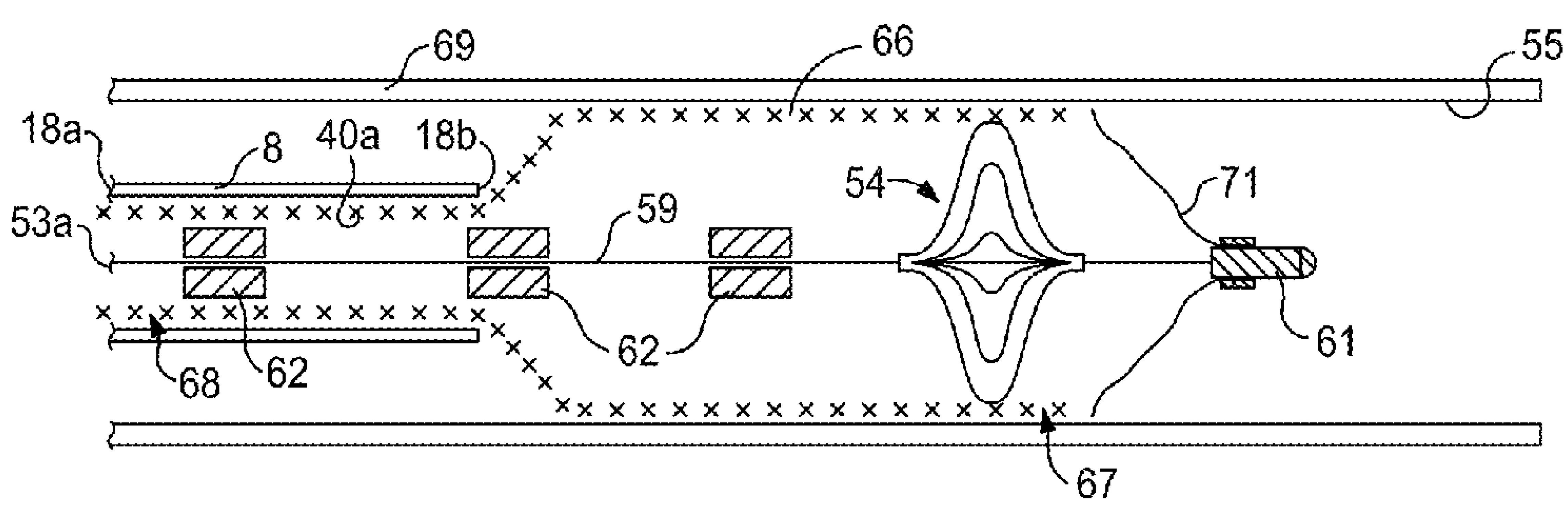
54b
71
54c
53a
59
26
68
62
40a
62
67
62
19
58b
61

FIG. 5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71
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61
67

FIG. 6

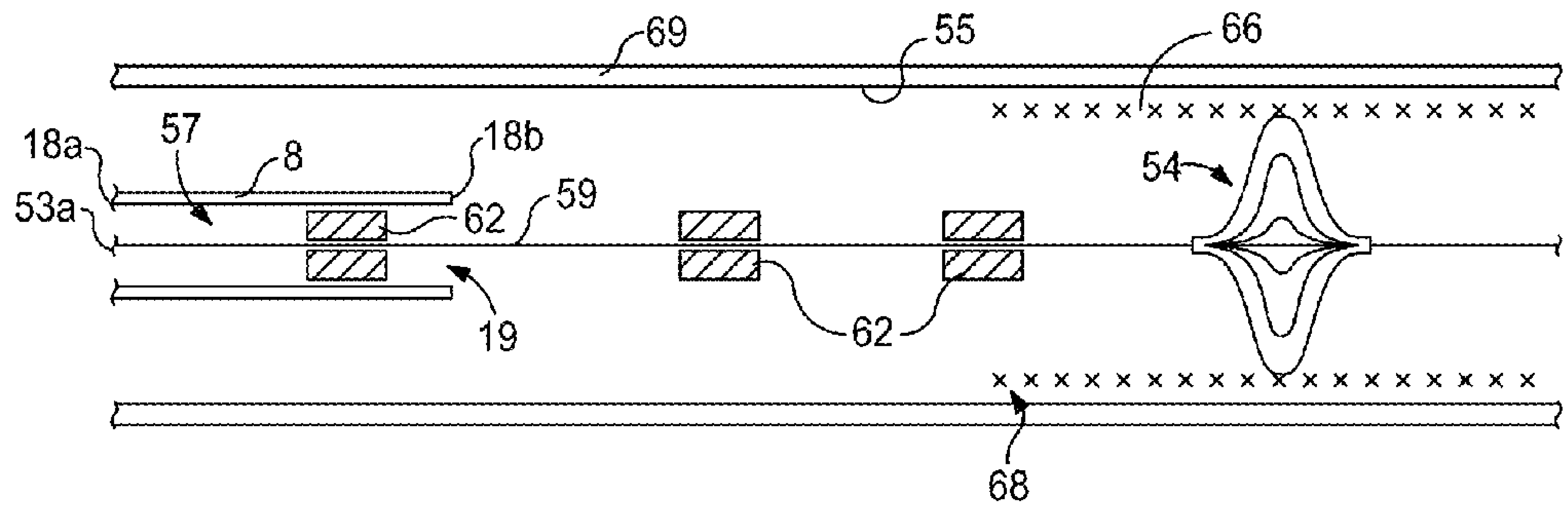

FIG. 7

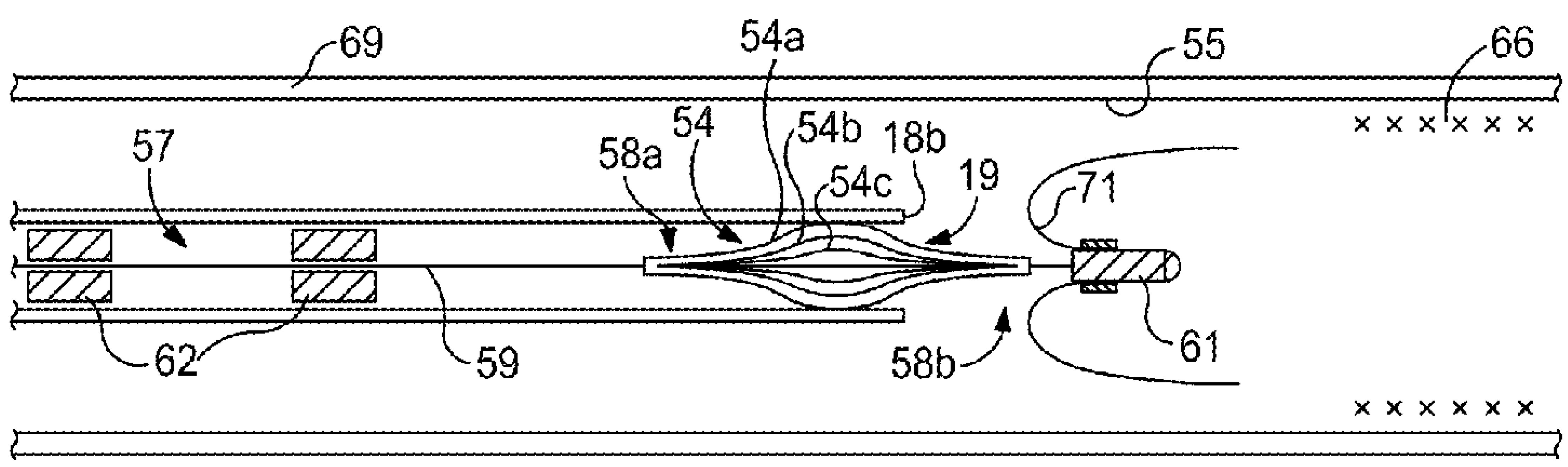

FIG. 8

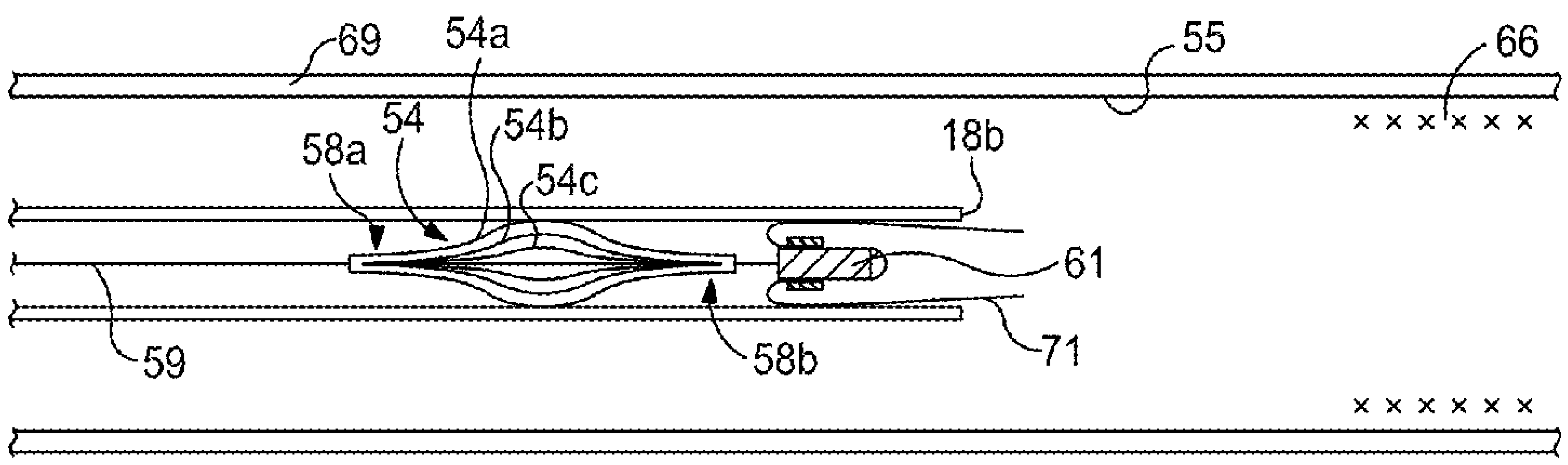

FIG. 9

METHODS AND APPARATUS FOR LUMINAL STENTING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/795,556, filed on Mar. 12, 2013, which claims priority to U.S. Provisional Patent Application No. 61/753,533, filed on Jan. 17, 2013, the entireties of each of which are incorporated herein by reference.

BACKGROUND

Field

The present application generally relates to implantable devices for use within a patient's body and, more particularly, relates to methods for implanting devices, such as stents, in a patient's body and monitoring an occlusion.

Description of the Related Art

Lumens in the body can change in size, shape, and/or patency, and such changes can present complications or affect associated body functions. For example, the walls of the vasculature, particularly arterial walls, may develop pathological dilatation called an aneurysm. Aneurysms are observed as a ballooning-out of the wall of an artery. This is a result of the vessel wall being weakened by disease, injury or a congenital abnormality. Aneurysms have thin, weak walls and have a tendency to rupture and are often caused or made worse by high blood pressure. Aneurysms can be found in different parts of the body; the most common being abdominal aortic aneurysms (AAA) and the brain or cerebral aneurysms. The mere presence of an aneurysm is not always life-threatening, but they can have serious heath consequences such as a stroke if one should rupture in the brain. Additionally, a ruptured aneurysm can also result in death.

SUMMARY

At least one aspect of the disclosure provides methods for implanting a device or devices (e.g., stent or stents) in the body. The device can easily conform to the shape of the tortuous vessels of the vasculature. The device can direct the blood flow within a vessel away from an aneurysm. Additionally, such a device can allow adequate blood flow to be provided to adjacent structures, such that those structures, whether they are branch vessels or oxygen demanding tissues, are not deprived of the necessary blood flow.

In accordance with some embodiments, a stent delivery system is provided that can comprise an elongate body, a stent, a core wire, and an expandable member. The elongate body can comprise a distal portion, a proximal portion, and an inner surface extending from the distal portion to the proximal portion. The distal portion can be configured to extend within a blood vessel of a patient. The stent can be expandable from a compressed configuration to an expanded configuration. The stent can have a proximal end, a distal end, an inner surface, and an outer surface. The inner and outer surfaces can extend from the proximal end to the distal end. The core wire can be extensible through the elongate body and the stent can have a distal region or terminal portion. The expandable member can be disposed along the core wire. The expandable member can be configured to facilitate the expansion of at least a portion of the stent to the expanded configuration by expanding and engaging the inner surface of the stent.

In some embodiments, the expandable member can comprise first and second ends that are rotatably and slidably movable relative to the core wire. The expandable member can be positioned proximally of the stent proximal end when the stent is in the compressed configuration. However, the expandable member can be positioned within a lumen of the stent when the stent is in the compressed configuration. The delivery system can further comprise at least one blocking member disposed along the core wire. The blocking member can be configured to limit the movement of the expandable member relative to the core wire. Further, the clinician can push or withdraw the core wire until the blocking member(s) contact(s) the expandable member, whereupon further pushing or withdrawing of the core wire allows the clinician to push or withdraw the expandable member.

In accordance with some embodiments, the blocking member(s) can engage with a distal end of the expandable member to push the expandable member distally. The blocking member(s) can also engage with a proximal end of the expandable member to withdraw the expandable member proximally. For example, the blocking member(s) can be disposed along the core wire between expandable member first and second ends, and the blocking member(s) can have an outer cross-sectional profile that is greater than an inner cross-sectional profile of the lumens of the expandable member first and second ends. Further, in such embodiments, the blocking member(s) can be a fixed blocking member. In some embodiments, the fixed blocking member can be fixed to the core wire.

Thus, in some embodiments, the expandable member can be moved proximally or distally without axially compressing the proximal and distal ends of the expandable member, which could cause the expandable member to invert or become jammed inside of the stent lumen.

For example, the at least one blocking member can comprise at least one fixed blocking member. The fixed blocking member can be fixed to the core wire. The fixed blocking member can define an outer profile or cross-section that is greater than an inner profile or cross-section of a lumen of the movable blocking member. Accordingly, one or more fixed blocking members can be positioned along the core wire and interact with one and/or both of the ends of the expandable member to limit the travel thereof.

In some embodiments, the at least one blocking member can comprise at least one fixed blocking member and at least one movable blocking member. In such embodiments, the movable blocking member can define an outer profile or cross-section that is greater than an inner profile or cross-section of a lumen of an end of the expandable member. Further, the movable blocking member can have a lumen that defines an inner profile or cross-section section that is less than an outer profile or cross-section of a fixed blocking member disposed along the core wire. The movable blocking member can be disposed between an end of the expandable member and the fixed blocking member. Thus, the end of the expandable member can be blocked from sliding past the movable blocking member and the fixed blocking member.

The expandable member can be configured to comprise a plurality of filaments extending from a first end to a second end thereof. Further, the expandable member can comprise a shape memory material. The expandable member can self-expand upon being unsheathed from a microcatheter, e.g., when radially unrestrained by the elongate body.

The system can also optionally comprise a distal stent cover extending proximally from the distal region of the core wire and interposed between the outer surface of the stent and the inner surface of the elongate member. The distal stent cover can comprise a folded region having (a) an outer layer configured to be urged against the inner surface of the elongate member and (b) an inner layer configured to contact the outer surface of the stent. Further, the folded region can be an inverted section of the distal stent cover where the distal stent cover folds within itself. The distal stent cover can be coupled to the core wire. Further, the distal stent cover can be formed by one or more flaps of material. The distal stent cover can also comprise a lubricious material.

The system can further comprise an atraumatic tip coil coupled to the distal region of the core wire. For example, the distal stent cover can be coupled to the tip coil. Further, the distal stent cover can be coupled to the tip coil by a shrink tube.

In accordance with some embodiments, a method of deploying a stent in a vessel of a patient is also provided. The method can include extending an elongate body within the vessel of the patient, the elongate body having an inner surface extending from a distal portion to a proximal portion of the elongate body; extending within the elongate body a core assembly having an expandable member and an expandable stent having an inner surface and a distal end; advancing, relative to and within the elongate body, the core assembly, wherein the stent and the expandable member are in a compressed configuration and the stent at least partially covers the expandable member; and expanding the expandable member and engaging the stent inner surface with the expandable member when at least the distal end of the stent is expanded. Expansion of the expandable member can contribute to the expansion of the stent by engaging an inner surface of the stent.

The method can be performed such that the advancing the expandable member with the stent comprises permitting expansion of the distal end of the stent using the expandable member upon being unsheathed from the distal portion of the elongate body, e.g., when radially unrestrained by the elongate body. The method can also be performed such that expanding of the expandable member comprises allowing the expandable member to self-expand or automatically expand when radially unrestrained by the elongate body.

The method can also comprise axially moving the expandable member within a lumen of the stent to facilitate expansion of at least a portion of the stent. The method can be performed such that axially moving the expandable member comprises axially moving the expandable member in proximal and distal directions within the lumen of the stent. The method can be performed such that axially moving the expandable member comprises preventing the expandable member from moving axially beyond the stent distal end. Further, the method can also be performed such that axially moving the expandable member comprises proximally withdrawing the expandable member within the stent lumen. Furthermore, the method can also be performed such that axially moving the expandable member comprises distally pushing the expandable member within the stent lumen.

In some embodiments, the core assembly can also comprise a distal stent cover. The distal stent cover can extend proximally from a distal region of a core wire extending through the stent and be interposed between an outer surface of the stent and the inner surface of the elongate member. In such embodiments, the method can further comprise advancing the core assembly out of the distal portion of the elongate body, such that the distal stent cover withdraws from the distal end of the stent as the stent expands.

The method can be performed such that the distal stent cover of the stent is extended in the elongate body with a proximal portion of the distal stent cover being inverted to form a folded region having an outer layer configured to be urged against the inner surface of the elongate member and an inner layer configured to contact the outer surface of the stent. Further, the method can also be performed such that the distal stent cover withdraws from the distal end. The folded region can be unfurled from between the inner surface of the elongate member and the outer surface of the stent. For example, in some embodiments, ends of the folded region can be inverted within the distal stent cover, such that the end of the distal stent cover forms the inner layer/surface between the outer surface of the stent and the distal stent cover. This can permit distal advancement of the core wire assembly through the catheter, while engaging the inner surface of the catheter, without unfurling. In addition, the distal stent cover can provide a lubricious interface between the distal end and the inner surface of the elongate member. For example, the distal stent cover can have a coefficient of friction of between about 0.02 and about 0.2. In some embodiments, the distal stent cover can have a coefficient of friction of about 0.04.

Additional features and advantages of the subject technology will be set forth in the description below, and in part will be apparent from the description, or may be learned by practice of the subject technology. The advantages of the subject technology will be realized and attained by the structure particularly pointed out in the written description and embodiments hereof as well as the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide further understanding of the subject technology and are incorporated in and constitute a part of this specification, illustrate aspects of the disclosure and together with the description serve to explain the principles of the subject technology.

FIG. **1** is a partial cross-sectional view of an exemplary stent delivery system, according to one or more embodiments disclosed.

FIG. **2** illustrates a cross-sectional view of an exemplary stent delivery system, according to one or more embodiments disclosed.

FIG. **3**A illustrates an enlarged, cross-sectional view of the distal end of the stent delivery system of FIG. **2**, according to one or more embodiments.

FIG. **3**B illustrates an enlarged, cross-sectional view of the distal end of another embodiment of the stent delivery system of FIG. **2**.

FIG. **3**C illustrates an enlarged, cross-sectional view of the distal end of yet another embodiment of the stent delivery system of FIG. **2**.

FIG. **3**D illustrates an enlarged, cross-sectional view of the distal end of yet another embodiment of the stent delivery system of FIG. **2**.

FIG. **3**E illustrates an enlarged, cross-sectional view of the distal end of yet another embodiment of the stent delivery system of FIG. **2**.

FIG. **3**F illustrates an enlarged, cross-sectional view of the distal end of yet another embodiment of the stent delivery system of FIG. **2**.

FIG. **3**G illustrates a perspective view of the distal end of yet another embodiment of the stent delivery system of FIG. **2**.

FIG. 4 illustrates an enlarged, cross-sectional view of an expandable member and bumpers positioned along a core wire, according to some embodiments.

FIG. 5 illustrates a stent delivery system with a partially deployed stent, according to one or more embodiments.

FIG. 6 illustrates a stent delivery system with a partially deployed stent, according to one or more embodiments.

FIG. 7 illustrates a stent delivery system with a fully deployed stent, according to one or more embodiments.

FIG. 8 illustrates an expandable member being resheathed into an elongate member or catheter, according to one or more embodiments.

FIG. 9 illustrates a further progression of the resheathing process of the stent delivery system, according to one or more embodiments.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth to provide a full understanding of the subject technology. It should be noted, however, that the subject technology may be practiced without some of these specific details. In other instances, well-known structures and techniques have not been shown in detail so as not to obscure the subject technology.

A discussion of aneurysm treatment technology, treatment methods (including delivery methods), and various delivery devices and stents, is disclosed in U.S. patent application Ser. No. 13/614,349, titled Methods and Apparatus for Luminal Stenting, filed on Sep. 13, 2012, the entirety of which is incorporated herein by reference.

Stents for use in practicing the technology disclosed herein can be configured to comprise one or more of a variety of structures and/or vascular devices, such as stent grafts, tubular embolization devices, braided implants, laser cut implants, scrolled implants, and other various implantable support, revascularization, and/or occluding devices. Further, in some embodiments, "occluding device" and "stent" as used herein can be used interchangeably. In some embodiments, "cell" and "pore" as used herein can be used interchangeably. In some embodiments, porosity refers to a value inversely proportional to lattice density.

Described herein are various embodiments of stent delivery systems which can exhibit small cross-sections and/or be highly flexible. Referring to FIG. **1**, an embodiment of a stent delivery system **20** is shown including a stent **100** carried by a core wire **41** arranged within an introducer sheath or catheter **4**. The stent delivery system **20** is shown in a pre-deployment, unexpanded, or collapsed state. The stent **100** and the core wire **41** can be cooperatively movable within the catheter **4** in order to deliver the stent **100** to a predetermined treatment site, such as an aneurysm, within the vasculature of a patient. Accordingly, the catheter **4** can be configured to be introduced and advanced through the vasculature of the patient. The catheter **4** can be made from various thermoplastics, e.g., polytetrafluoroethylene (PTFE or TEFLON®), fluorinated ethylene propylene (FEP), high-density polyethylene (HDPE), polyether ether ketone (PEEK), etc., which can optionally be lined on the inner surface of the catheter **4** or an adjacent surface with a hydrophilic material such as polyvinylpyrrolidone (PVP) or some other plastic coating. Additionally, either surface can be coated with various combinations of different materials, depending upon the desired results.

Information regarding additional embodiments, features, and other details of the occlusion devices or stents, methods of use, and other components that can optionally be used or implemented in embodiments of the occlusion devices or stents described herein, can be found in U.S. patent application Ser. No. 13/614,349, titled Methods and Apparatus for Luminal Stenting, filed on Sep. 13, 2012, the entirety of which is incorporated herein by reference.

The stent **100** can be characterized as a vascular occluding device, a revascularization device and/or an embolization device. The stent **100** can comprise a proximal end and a distal end. The stent **100** can comprise a braided stent or other form of stent such as a laser-cut stent, roll-up stent, etc. In some embodiments, the stent **100** can be an expandable stent made of two or more filaments. The filaments can be formed of known flexible materials including shape memory materials, such as nitinol, platinum and stainless steel. In some embodiments, the filaments can be round or ovoid wire. Further, the filaments can be configured such that the stent is self-expanding. In some embodiments, the stent **100** is fabricated from platinum/8% tungsten and 35N LT (cobalt nickel alloy, which is a low titanium version of MP35N alloy) alloy wires. In some embodiments, one or more of the filaments can be formed of a biocompatible metal material or a biocompatible polymer.

The stent **100** can optionally be configured to act as a "flow diverter" device for treatment of aneurysms, such as those found in blood vessels including arteries in the brain or within the cranium, or in other locations in the body such as peripheral arteries. The stent **100** can optionally be similar to any of the versions or sizes of the PIPELINE™ Embolization Device marketed by Covidien of Mansfield, Mass. USA. The stent **100** can further alternatively comprise any suitable tubular medical device and/or other features, as described herein.

The wire filaments can be braided into a resulting lattice-like structure. In some embodiments, during braiding or winding of the stent **100**, the filaments can be loosely braided using a 1-over-2-under-2 pattern. In other embodiments, however, other methods of braiding can be followed, without departing from the scope of the disclosure. The stent **100** can exhibit a porosity configured to reduce haemodynamic flow into, for example, an aneurysm, but simultaneously allow perfusion to an adjacent branch vessel. As will be appreciated, the porosity of the stent **100** can be adjusted by "packing" the stent during deployment, as known in the art. The ends of the stent **100** can be cut to length and therefore remain free for radial expansion and contraction. The stent **100** can exhibit a high degree of flexibility due to the materials used, the density (i.e., the porosity) of the filaments, and the fact that the ends are not secured.

The flexibility of the core wire **41** allows the stent delivery system **20** to bend and conform to the curvature of the vasculature as needed for positional movement of the stent **100** within the vasculature. The core wire **41** can be made of a conventional guidewire material and have a solid cross-section. Alternatively, the core wire **41** can be formed from a hypotube. The material used for the core wire **41** can be any of the known guidewire materials including superelastic metals or shape memory alloys, e.g., nitinol. Alternatively, the core wire **41** can be formed of metals such as stainless steel.

In one or more embodiments, the stent delivery system **20** can exhibit the same degree of flexion along its entire length. In other embodiments, however, the stent delivery system **20** can have two or more longitudinal sections, each with differing degrees of flexion or stiffness. The different degrees of flexions for the stent delivery system **20** can be created using different materials and/or thicknesses within different longitudinal sections of the core wire **41**. In another embodiment, the flexion of the core wire **41** can be controlled by spaced cuts (not shown) formed within the core wire **41**. These cuts can be longitudinally and/or circumferentially spaced from each other.

A tip **28** and flexible tip coil **29** can be secured to the distal end **27** of the core wire **41**. The tip **28** can be characterized as a distal solder joint formed of a continuous end cap or cover as shown in the figures, which securely receives or is embedded in a distal end of the tip coil **29**. Flexion control is provided to the distal end **27** of the core wire **41** by the tip coil **29**. However, in some embodiments, the tip **28** can be free of the coil **29**. As illustrated, the tip **28** can have a non-puncturing, atraumatic end face. The tip coil **29** can be configured to surround at least a portion of the core wire **41**. The tip coil **29** is flexible so that it will conform to and follow the path of a vessel within the patient as the tip **28** is advanced along the vessel and the core wire **41** bends to follow the tortuous path of the vasculature.

At the proximal end **107** of the stent **100**, a proximal solder joint **52** and proximal marker **88** prevent or limit longitudinal movement of the stent **100** along the length of the core wire **41** in the direction of the proximal end **107**. As illustrated, the proximal end **107** of the stent **100** can be axially offset from the proximal marker **88** by a short distance. In other embodiments, however, the stent **100** can shift axially during introduction into the vasculature of the patient and contact the proximal marker **88** which prevents or limits the stent **100** from moving along the length of the core wire **41** away from a distally located protective coil **85** coupled to an adjacent or mid solder joint **82**.

After navigating the length of the catheter **4** to the predetermined treatment site within the patient, the stent **100** can be deployed from the catheter **4** in a variety of ways. In some embodiments, the catheter **4** is retracted while maintaining the position of the core wire **41** to expose the distal end **27** of the core wire **41** and the distal end **102** of the stent **100**. Upon exiting the catheter **4**, the portion of the stent **100** that is not situated between the protective coil **85** and the core wire **41** and that is not covered by the catheter **4** begins to expand radially. The catheter **4** can then be further retracted until enough of the stent **100** is exposed, such that the expansion diameter of the stent **100** is sufficient to engage the walls of the vessel (not shown), such as a blood vessel. Upon engaging a portion of said vessel, the stent **100** can be at least partially anchored within the vessel.

The core wire **41** can then be rotated at its proximal end, which causes rotation at the distal end **27** relative to the stent **100**. The rotation of the core wire **41** also causes twisting of the protective coil **85**, which pushes the distal end **102** of the stent **100** out from beneath the protective coil **85** like a corkscrew. Once the distal end **102** of the stent **100** is released from the protective coil **85**, it expands to engage the walls of the vessel. The catheter **4** can then be further retracted to expose and expand the remaining portions of the stent **100** into engagement with the blood vessel wall.

Variations of this deployment method are possible. For example, the catheter **4** can be further retracted before rotating the core wire **41**, thereby expanding the proximal end **107** of the stent **100** before expanding the distal end **102**. Other examples of deployment variations include causing or otherwise creating variable porosity of the stent **100**.

Once the entire stent **100** is expanded, the core wire **41** can then be retracted back into the catheter **4** by pulling proximally on the core wire **41** and maintaining the catheter **4** in its position. The proximal taper of the solder joint **52** coupled to the proximal marker **88** helps guide retraction of the core wire **41** back into the catheter **4**. The core wire **41** and the catheter **4** can then be both retracted from the vessel and vasculature of the patient.

Referring now to FIG. **2**, illustrated is a cross-sectional view of another embodiment of a stent delivery system **5**, according to one or more embodiments disclosed. The system **5** can include an elongate body, such as a catheter **8**, a core assembly **57** extending generally longitudinally through the catheter **8** (e.g., a microcatheter), and a stent **66** loaded onto the core assembly **57**. The elongate body or catheter **8** can define a lumen extending therethrough from a proximal portion to a distal portion thereof. The core assembly **57** can be slidably received within the catheter **8** and used to deploy the stent **66** in a lumen, such as the blood vessel **69** shown in FIGS. **5-9**.

In some embodiments, the stent **66** can be a self-expanding stent. However, the stent **66** can also be configured to be expanded using other means, such as a balloon and the like. The stent **66** can, in various embodiments, be similar to any of the embodiments of the stent **100** disclosed herein.

The stent **66** can define a lumen extending therethrough and include an inner surface **40***a*, an outer surface **40***b*, a distal end **67**, and a proximal end **68**. The stent **66** can be loaded onto the core assembly **57** in a compressed configuration within the catheter **8**, as shown in FIG. **2**. In one or more embodiments, the stent **66** is maintained in its compressed configuration within the catheter **8** by an inner surface **17** of the catheter **8**. Some embodiments of the stent **66** can be configured to automatically expand or self-expand radially from its compressed configuration to its expanded configuration as the stent **66** is deployed from the catheter **8** and into a blood vessel, as discussed in more detail below.

The elongate body or catheter **8** can extend longitudinally from a proximal portion **18***a* to a distal portion **18***b*. At the distal portion **18***b*, the catheter **8** defines a distal opening **19** through which the core assembly **57** can be advanced beyond the distal portion **18***b* in order to deploy the stent **66** within the blood vessel. A proximal opening (not shown) is defined at the opposing end of the catheter **8** through which the core assembly **57** can be initially inserted into the catheter **8**.

As illustrated in FIG. **2**, the core assembly **57** includes a core wire **59** or other core member as disclosed herein extending generally longitudinally through a lumen of the catheter **8** and terminating at a flexible tip coil **61**. In particular, the core wire **59** has a proximal end **53***a* and a terminal or distal end **53***b*, and the tip coil **61** can be coupled to the distal (terminal) end **53***b* of the core wire **59**. In some embodiments, the tip coil **61** can be substantially similar to the tip **28** and tip coil **29** combination described above with reference to FIG. **1**, and the core wire **59** can be substantially similar to the core wire **41**, also described above with reference to FIG. **1**. The tip coil **61** can have an atraumatic end face, such as a rounded or smoothed face. In other embodiments, the tip coil **61** can have other atraumatic shapes designed to prevent injury to the vessel into which it can be introduced.

The core wire **59** can be sufficiently flexible to allow flexure and bend as it traverses tortuous vessels. Moreover, the core wire **59** can be secured to the tip coil **61**, such that the tip coil **61** is able to be translated within the catheter **8** and/or a blood vessel by manipulating the axial position of the core wire **59**. In some embodiments, the core wire **59** is configured to transmit torque and axial or longitudinal force from the proximal end **53***a* of the core wire **59** through the distal end **53***b* to the tip coil **61**.

The core assembly **57** can also include a proximal retaining member or proximal bumper **26** and one or more stent bumpers or pads **62**. The proximal retaining member **26** can be spaced proximally from the tip coil **61**. Further, the proximal retaining member **26** can be concentrically disposed within the catheter **8**. Additionally, the proximal retaining member **26** can define a width or diameter that is approximately equal to an inside diameter of the lumen of the catheter **8**. However, the width or diameter of the proximal retaining member **26** can be much less than the inside diameter of the lumen of the catheter **8**. The proximal retaining member **26** can be generally circular or cylindrical in shape. However, the proximal retaining member **26** can also define other geometries, such as square, rectangular, triangular, or have other features that can be configured to interact with the stent **66** in a manner providing a proximal limit or boundary. Thus, the proximal retaining member **26** can comprise a core connector and one or more stent abutment portions extending from the core connector that can contact the stent **66** to provide a proximal limit or boundary.

The proximal retaining member **26** can comprise a radiopaque marker to facilitate the locating and viewing of the core assembly **57** in the blood vessel. For example, the proximal retaining member or bumper **26** can comprise a marker band **26***a* fixed to the core wire **59** via a solder bead **26***b*. The marker band **26***a* can be a generally cylindrical structure made of platinum or other radiopaque material. In some embodiments, the proximal bumper **26** can be arranged in the core assembly **59**, such that there is a small gap defined between the proximal bumper **26** and the stent **66**. For example, in some embodiments, a gap ranging between about 0.0 mm to about 0.5 mm can be defined between the proximal bumper **26** and the stent **66**. In one or more other embodiments, the proximal bumper **26** can be substantially similar to the combination solder joint **52** and proximal marker **88** described above with reference to FIG. **1**.

Further, in some embodiments, a portion of the stent **66** can be engageable with or disposed within a proximal mechanism and/or the proximal retaining member. In such embodiments, the stent **66** can be disengageable from the proximal mechanism and/or proximal retaining member by axially moving a sleeve and/or rotating the proximal bumper **26** via the proximal end **53***a* of the core wire **59**. In other embodiments, however, the proximal bumper **26** can be an axial stent bumper that is coupled to the core wire **59** and configured to urge or bias the stent **66** in the distal direction via the proximal end **68**.

In those embodiments where the marker band **26***a* of the proximal bumper **26** is made of platinum or another radiopaque material or substance visible through CAT scan, X-Ray, MM, or ultrasound technology, a user can be able to pinpoint the location and track the progression of the proximal end **68** of the stent **66** within the catheter **8** or blood vessel by determining the location of the proximal bumper **26**.

The stent bumper(s) **62** can be spaced longitudinally along the core wire **59** and coupled thereto for mutual movement. Although three stent bumpers **62** are illustrated, more or fewer than three stent bumpers **62** can be used in the system **5**, without departing from the scope of the disclosure. Moreover, the stent bumpers **62** can be equidistantly spaced or randomly spaced along the core wire **59**, depending on the application. In some embodiments, one or more of the stent bumpers **62** can be shrink tubes coupled to the core wire **59** by shrinking the stent bumpers **62** directly onto the core wire **59**. In other embodiments, one or more of the stent bumpers **62** are coupled to the core wire **59** via other attachment means including, but not limited to, mechanical fasteners, welding techniques, adhesives, combinations thereof, or the like.

The stent bumper(s) **62** can comprise a soft or compressible polymer or elastomer that is fixed to the core wire **59** and can form a generally cylindrical outer surface. The polymer or elastomer can overlie one or more metallic coils that are wound around and welded to the core wire **59**. For example, two spaced coils of stainless steel or platinum-tungsten can be employed in the construction of a single bumper **62**. To enhance flexibility the coils can have an open-pitch configuration, be welded to the core wire **59** only at the end points, and/or separated by a slight gap that is similar in size to the pitch employed in the coils. The polymer or elastomer can form a generally cylindrical outer surface along the portion that overlies the coil(s), and taper down toward the core wire **59** distal end proximal of the coil(s). The polymer or elastomer can comprise Pebax (e.g., Pebax 3533), PTFE, FEP, silicone, or other medical grade polymers or elastomers.

In its compressed state within the catheter **8**, the stent **66** can underlie the sidewall of the catheter **8** and overlies the stent bumper(s) **62**. Specifically, the inner surface **40***a* of the stent **66** can contact the outer radial surface of the stent bumpers **62**, and the outer surface **40***b* of the stent **66** can contact the inner radial surface **17** of the catheter **8**. In some embodiments, the stent bumpers **62** can be sized or otherwise configured to engage the inner surface **40***a* of the stent **66** sufficiently to exceed the coefficient of friction between the outer surface **40***b* of the stent **66** and the inner surface **17** of the catheter **8**. As a result, the stent bumpers **62** can translate the stent **66** axially within the catheter **8** without the stent **66** binding against the inner surface **17** of the catheter **8**. Moreover, this arrangement can enable the stent **66** to be resheathable, or to be drawn back within the catheter **8**, as long as at least a portion of the stent **66** remains interposed between the inner surface **17** of the catheter **8** and one or more of the stent bumpers **62**.

Additionally, in some embodiments, the core assembly can optionally comprise at least one expandable member. The expandable member can comprise one or more arms, radial members, or filaments that can move from a collapsed position to an expanded position. When moved to the expanded position, the expandable member can facilitate deployment of the stent. The expandable member can comprise a resilient, flexible material that can automatically or manually expand from the collapsed state. In some embodiments, the expandable member can comprise a shape memory material that expands when radially unrestrained by the elongate body.

The expandable member can be configured to slide and/or rotate relative to the core wire. The expandable member can be positioned at any of a variety of locations along the core wire.

For example, an expandable member(s) can facilitate initial expansion of one or more portions of the stent. In some embodiments, an expandable member can be positioned at a distal portion of the core assembly under a distal portion of the stent, such that upon exiting the microcatheter, the expandable member immediately self-expands under the stent and urges the stent towards an expanded position.

Further, an expandable member(s) can be used to ensure that the stent has fully deployed at all portions thereof. For example, when radially unrestrained by the elongate body or microcatheter, it is possible that a stent may have one or more portions that have not fully expanded into apposition with the vessel wall. In such situations, the expandable member(s) of the core assembly can be axially moved along and within the lumen of the stent, and thereby employed to push the non-expanded portion(s) of the stent radially outward into contact with the inner surface of the blood vessel.

In accordance with some embodiments, the expandable member can comprise a plurality of filaments that extend in a curvilinear manner. The expandable member can comprise an "onion-shaped" structure, an ellipsoid of revolution, a prolate spheroid, etc. Advantageously, embodiments having filaments in a "bell curve" shape can allow the expandable member to be urged both distally and proximally within a lumen of the stent ("brushed" or "brushing") without harming the framework of the stent or otherwise snagging with the stent or inner of the vessel. Various advantageous geometries can be provided that facilitate initial expansion of one or more portions of the stent that do not require proximal and distal movement. Thus, some embodiments can be provided that are suitable for initial expansion while others are suitable for brushing, and yet other embodiments can be provided that are suitable for both.

Further, the core assembly can comprise one or more blocking components for limiting axial and/or rotational movement of the at least one expandable member. The one or more blocking components can comprise at least one fixed blocking component and/or at least one movable blocking component. The blocking component(s) and the expandable member can interact or engage with each other in an axial direction or a rotational direction. The interaction between the blocking component(s) and the expandable member can thereby permit or limit certain types of motion of the expandable member.

The blocking component(s) can be formed separately from the core wire and/or integrally with the core wire (e.g., both being formed from a single piece of material). In embodiments having more than one blocking component, one blocking component can be formed separately from the core wire while another blocking component can be formed integrally with the core wire. Further, the shape and dimensions of the blocking component(s) can define a variety of geometries operative to provide a desired interaction with each other and/or with the expandable member.

For example, as illustrated in FIG. **2**, the core assembly **57** can further include one or more optional expandable members **54** arranged at or near the distal end **53***b* of the core wire **59**. Although embodiments illustrated and discussed herein refer to a single expandable member, two or more expandable members can be used in some embodiments. Further, the discussion of certain features can also be extended to multiple expandable members in such embodiments.

As illustrated in the embodiment shown in FIG. **2**, the expandable member **54** can comprise one or more generally longitudinally arranged expandable struts extending from a proximal end **58***a* to a distal end **58***b*. In some embodiments, the struts can be self-expanding, such that the expandable member **54** can move on its own to an expanded configuration from a collapsed configuration. Therefore, in some embodiments, movement of the expandable member **54** to the expanded configuration can be automatic or self-expanding. For example, the struts can be heat set, preformed, or otherwise configured to expand from a collapsed state to an expanded state. The struts can form a shape that is generally spherical, bulbous, or otherwise radially extending from the core wire. Further, the struts can define a generally smooth outer profile for the expandable member **54** that can allow the expandable member **54** to be moved within the lumen and against the inner surface of the stent **66**.

Referring still to the embodiment illustrated in FIG. **2**, the expandable struts or members **54***a*, **54***b*, and **54***c* can extend from the core wire **59** into contact with an inner surface of the stent **66**. In one or more embodiments, the expandable member **54** can be formed from a generally tubular structure (e.g., a hypotube) made of shape-memory or super-elastic materials, such as nitinol, or other resilient materials. The struts **54***a-c* can be laser-cut into a middle or central portion of the expandable member **54**, and the proximal and distal ends **58***a, b* can therefore be short lengths of the uncut tubular structure. The members **54***a-c* can be configured to automatically or manually assume an expanded state (e.g., self-expand) when deployed out the distal end **19** of the catheter **8**, or when unrestrained by the catheter. While disposed within the catheter **8**, the members **54***a-c* are compressed against their natural disposition and consequently urge an overlying portion of the stent **66** radially outward. When unrestrained or otherwise expanded, however, each respective member **54***a-c* expands radially in various angular directions about the core wire **59**.

The expandable member can be coupled to the core wire in a manner that permits relative movement therebetween as the core wire translates within the catheter and/or a blood vessel. According to some embodiments, one or both ends of the expandable member can be axially freely movable along the core wire. In some embodiments, at least one end of the expandable member can be formed with, bonded, fixed, constrained, or fixedly coupled relative to the core wire to permit limited movement or no movement of the end of the expandable member relative to the core wire.

For example, in some embodiments, the proximal end **58***a* can be secured relative to the core wire **59**. In other embodiments, the distal end **58***b* can be secured relative to the core wire **59**. In some embodiments, one of the ends of the expandable member **54** can be directly coupled to the core wire **59**. Further, although the expandable member can have two ends that are each coupled to the core wire (whether slidably or fixedly), other embodiments can be configured such that the expandable member is coupled to the core wire at only a single end of the expandable member. Such embodiments can be configured such that the expandable member has a free end unconnected to the core wire that is resiliently movable relative to the core wire.

For example, as illustrated in the embodiment of the system **5***b* shown in FIG. **3**B, one or more attachment means or coupling devices **60***b* can be used to secure the proximal end **58***ab* of the expandable member **54***b* to the core wire **59***b*. The coupling device **60***b* can comprise a mechanical fastener, shrink tubing, a weld, adhesives, heat bonding, combinations thereof, or the like, or an uncut proximal tubular portion of the hypotube which is cut to form the expandable member **54***b*. In some embodiments, the proximal end **58***ab* can be fixedly coupled with the core wire **59***b*, and the distal end **58***bb* of the expandable member **54***b* can remain free to move on and along the core wire **59***b*. As a result, as the struts of the expandable member **54***b* expand, the distal end **58***bb* can be free to slidably move along the core wire **59***b* toward the proximal end **58***ab*, thereby facilitating expansion or contraction of the expandable member **54***b*. In other embodiments, however, the expandable member **54***b* can be fixedly coupled to the core wire **59***b* at its distal end **58***bb* instead of at its proximal end **58***ab*, thereby allowing the proximal end **58***ab* of the expandable member **54***b* to remain free, and likewise longitudinally translate, as generally described above.

In accordance with some embodiments, the expandable member can be coupled to the core wire and positioned proximally of the proximal bumper **26**. The expandable member can therefore be positioned outside of the stent lumen when the stent is in the collapsed configuration. Thus, while the expandable member may not assist in the initial expansion of the stent, the expandable member could be used as a dedicated mechanism that assists in fully expanding the stent after the stent has been released and initially expanded. In such embodiments, the expandable member could be inserted into the stent through the stent proximal end and moved within the stent lumen until all portions of the stent are fully expanded.

Additionally, in some embodiments, both ends of the expandable member can be axially and/or rotatably freely movable along and/or about the core wire. Thus, one or both of the ends of the expandable member can rotate and/or translate along the core wire. In such embodiments, the core wire can comprise one or more blocking structures operative to limit the axial and/or rotational movement of one or both of the ends of the expandable member.

The blocking structures can comprise one or more movable blocking structures and/or one or more fixed blocking structures. For example, a movable blocking structure can be configured to slide and/or rotate along the core wire. A fixed blocking structure can be axially and/or rotatably fixed relative to the core wire. The fixed blocking structure can be formed separately from the core wire and bonded or otherwise attached to the core wire. However, the fixed blocking structure can also be formed integrally with the core wire. Further, the distal tip of the core assembly can act as or be a fixed blocking structure (see FIG. **3**D). In some embodiments, the movable blocking structure can interact with the fixed blocking structure and one or both of the ends of the expandable member to limit movement of the expandable member.

For example, as shown in FIG. **3**G, a fixed blocking structure **160***g* can be rotatably and axially fixed relative to the core wire **59***g*. A movable blocking structure **60***g* can be disposed on the core wire **59***g* and permitted to freely rotate and move axially along the core wire **59***g*. Further, an end **58***ag* (which can be proximal and/or distal) of an expandable member **54***g* can also be rotatably and axially movable along the core wire **59***g*. As illustrated, the fixed blocking structure **160***g* can define an outer profile or cross-sectional profile **160***g*' that is greater than an inner profile or cross-sectional profile **60***g*" of the movable blocking structure **60***g*. Accordingly, an end surface of the fixed blocking structure **160***g* can be operative to contact a corresponding surface of the movable blocking structure **60***g* to prevent the movable blocking structure **60***g* from moving axially past the fixed blocking structure **160***g*. Thus, the fixed blocking structure **160***g* can serve as a limit of travel of the movable blocking structure **60***g*.

In addition, in some embodiments, the movable blocking structure **60***g* can define an outer cross-reference sectional profile **60***g*' that is greater than an inner profile or cross-sectional profile **58***ag*" of the end **58***ag* of the expandable member **54***g*. As such, an end surface of the movable blocking structure **60***g* can be operative to contact the end **58***ag* of the expandable member **54***g* and prevent the expandable member **54***g* from moving past the movable blocking structure **60***g*.

Further, in embodiments that use both a fixed blocking structure **160***g* and a movable blocking structure **60***g*, movement of the end **58***ag* of the expandable member **54***g* can be limited through indirect contact with the fixed blocking structure **160***g*.

In some embodiments, the movable blocking structure **60***g* can be disposed outside of the ends (or lumen) of the expandable member **54***g*. However, in other embodiments, the movable blocking structure **60***g* can be disposed inside or between the ends (or lumen) of the expandable member **54***g*. Further, one or more movable blocking structures can be used in some embodiments. Additionally, one or more fixed blocking structures can be used in some embodiments.

In some embodiments, both ends of the expandable member can be confined or limited to a length of travel. For example, in some embodiments, both ends can be positioned between a pair of blocking structures that are spaced at a minimum axial distance that is approximately equal to the length of individual struts of the expandable member. Accordingly, both ends of the expandable member could be axially movable until the expandable member is fully compressed or collapsed to permit the expandable member to be stowed within the lumen of the catheter. Further, one or more blocking structures can be placed between both ends of the expandable member, such that both ends can move axially in either direction, but are limited from further axial movement upon contact with the one or more blocking structures.

Further, some embodiments can be configured such that only one of the ends of the expandable member is confined or limited to a length of travel. For example, a first end of the expandable member can be positioned between the pair of blocking structures, such that the first end is constrained by the blocking structures while a second end of the expandable member is unconstrained and generally free to move.

Various configurations of the blocking structure(s) and the expandable member can be developed using the teachings disclosed herein. The following embodiments illustrate possible configurations, and shall not be considered to limit the disclosure herein.

Referring initially to embodiments illustrated in FIG. **3**C, a system **5***c* is shown in which a pair of blocking members **60***c* are positioned on either side of the proximal end **58***ac* of the expandable member **54***c*. The blocking members **60***c* can be fixed relative to the core wire **59***c*. Thus, travel of the proximal end **58***ac* of the expandable member **54***c* can be limited to the space defined between the blocking members **60***c*. However, the distal end **58***bc* can be free to travel. Thus, the axial position of the distal end **58***bc* can be responsive to movement of the proximal end **58***ac*, compression of the expandable member **54***c*, and/or expansion of the expandable member **54***c*.

FIG. **3**D illustrates an embodiment of a system **5***d* in which an expandable member **54***d* is slidable along a core wire **59***d*. The system **5***d* can comprise a fixed blocking member **160***d* and a movable blocking member **60***d*. The fixed blocking member **160***d* can define an outer profile or cross-section that is greater than an inner profile or cross-section of a lumen of the movable blocking member **60***d*, thus preventing the movable blocking member **60***d* from be able to pass or slide over fixed blocking member **160***d*.

The movable blocking member **60***d* can be disposed axially between the proximal and distal ends **58***ad*, **58***bd* of the expandable member **54***d*. The movable blocking member **60***d* can be configured to define an outer profile or cross-section that is greater than the inner profile of the lumens of the proximal and distal ends **58***ad*, **58***bd* of the expandable member **54***d*.

Further, in some embodiments, the lumen of the proximal end **58***ad* of the expandable member **54***d* can define a profile or cross-section that is greater than an outer profile or cross-section of the fixed blocking member **160***d*. Thus, although the proximal end **58***ad* can traverse or axially pass or slide over the fixed blocking member **160***d*, the proximal movement of the expandable member **54***d* can be limited upon contact between the fixed blocking member **160***d*, the movable blocking member **60***d*, and the distal end **58***bd* of the expandable member **54***d*. Further, distal movement of the expandable member **54***d* can be limited upon contact between the distal end **58***bd* of the expandable member **54***d* and the distal tip portion **7***d*.

FIG. **3**E illustrates an embodiment of another system **5***e* in which an expandable member **54***e* is slidable along a core wire **59***e*. The system **5***e* can comprise a pair of fixed blocking members **160***e*, **160***e*' and a movable blocking member **60***e*. The movable blocking member **60***e* is disposed axially between the proximal and distal ends **58***ae*, **58***be* of the expandable member **54***e*. The fixed blocking members **160***e*, **160***e*' can define outer profiles or cross-sections that are greater than an inner profile or cross-section of a lumen of the movable blocking member **60***e*, thus preventing the movable blocking member **60***e* from be able to pass or slide over fixed blocking members **160***e*, **160***e'*.

The movable blocking member **60***e* can define an outer profile or cross-section that is greater than the inner cross section of the lumens of the proximal and distal ends **58***ae*, **58***be* of the expandable member **54***e*. Further, the lumen of the proximal end **58***ae* of the expandable member **54***e* can define a profile or cross-section that is greater than an outer profile or cross-section of the fixed blocking member **160***e*, and the lumen of the distal end **58***be* of the expandable member **54***e* can define a profile or cross-section that is greater than an outer profile or cross-section of the fixed blocking member **160***e'*.

Accordingly, in some embodiments, the proximal end **58***ae* can traverse or axially pass or slide over the fixed blocking member **160***e*, and the distal end **58***be* can traverse or axially pass or slide over the fixed blocking member **160***e*'. However, the proximal movement of the expandable member **54***e* can be limited upon contact between the fixed blocking member **160***e*, the movable blocking member **60***d*, and the distal end **58***bd* of the expandable member **54***d*. Further, the distal movement of the expandable member **54***e* can be limited upon contact between the fixed blocking member **160***e*', the movable blocking member **60***e*, and the proximal end **58***ae* of the expandable member **54***e*.

FIG. **3**F illustrates yet another embodiment of a system **5***f* in which expandable member **54***f* is slidable along the core wire **59***f*. In this embodiment, the system **5***f* can comprise a pair of movable blocking members **60***f*, **60***f*' and a single fixed blocking member **160***f* interposed between the movable blocking members **60***f*, **60***f*'. The fixed blocking member **160***f* can define an outer profile or cross-section that is greater than an inner profile or cross-section of a lumen of the movable blocking members **60***f*, **60***f*', thus preventing the movable blocking members **60***f*, **60***f*' from be able to pass or slide over fixed blocking member **160***f*.

Further, as similarly noted with respect to the above embodiments, the movable blocking members **60***f*, **60***f*' can define outer cross sections that are greater than the inner profiles of the lumens of the proximal and distal ends **58***af*, **58***bf* of the expandable member **54***f*. Thus, proximal movement of the expandable member **54***f* can be limited upon contact between the distal end **58***bf* of the expandable member **54***f*, the movable locking structure **60***f*, and the fixed blocking structure **160***f* Further, distal movement of the expandable member **54***f* can be limited upon contact between the proximal end **58***af* of the expandable member **54***f*, the movable locking structure **60***f*, and the fixed blocking structure **160***f*.

In accordance with some embodiments, the expandable member can be configured such that the size of the lumens of the proximal and distal ends can be configured to allow passage of some fixed blocking members while preventing the passage of other fixed blocking members. A proximal fixed blocking member can be sized larger than a lumen of a proximal end of the expandable member, such that the proximal fixed blocking member does not permit the expandable member to pass any further proximally once the proximal fixed blocking member contacts the proximal end of the expandable member. Additionally, the size of the lumen of the proximal end of the expandable member can also be smaller than one or more distal fixed blocking members disposed along the core wire, similarly preventing the proximal end of the expandable member from advancing any further distally once the proximal end of the expandable member contacts the given distal fixed blocking member.

However, the distal end of the expandable member can comprise a lumen that is larger than a distal fixed blocking member, such that the distal end of the expandable member can pass over the distal fixed blocking member, allowing the distal end of the expandable member to be generally unconstrained relative to one or more distal fixed blocking members.

For example, FIG. **4** illustrates an embodiment of a configuration comprising an expandable member **54***k*, a core wire **59***k*, and one or more fixed blocking members **160***k*, **160***k*'. As shown, the expandable member **54***k* can comprise a proximal end **58***ak* and a distal end **58***bk*. The proximal and distal ends **58***ak*, **58***bk* can each define lumens through which the core wire **59***k* can be slidably placed.

The expandable member **54***k*, in some embodiments, can slide relative to the core wire **59***k*. The length of travel of the expandable member **54***k* can be limited by the distance between the fixed blocking members **160***k*, **160***k*'. Further, the proximal and distal ends **58***ak*, **58***bk* of the expandable member **54***k* can move relative to each other based on the expansion of the expandable member **54***k*.

In some embodiments, the lumen of the distal end **58***bk* can define a diameter that is greater than a diameter of the fixed blocking member **160***k*'. However, the outer profile or shape of the fixed blocking member **160***k*' and the lumen of the distal end **58***bk* can comprise shapes other than circular.

In accordance with some embodiments, the lumen of the distal end **58***bk* can be sized to allow the fixed blocking member **160***k*' to pass therethrough. However, the lumen of the proximal end **58***ak* can be sized to prevent passage of the fixed blocking members **160***k*, **160***k*' therethrough. Accordingly, in some embodiments, the outside diameter of the fixed blocking members **160***k*, **160***k*' can be greater than the inside diameter of the lumen of the proximal end **58***ak*. Further, the inside diameter of the distal end **58***bk* can be greater than the outside diameter of the fixed blocking member **160***k*'. Thus, in this embodiment, the proximal end **58***ak* of the expandable member **54***k* can be pushed distally by the fixed blocking member **160***k* or pulled proximally by the fixed blocking member **160***k*' while the distal end **58***bk* will not constrain or be constrained by the fixed blocking member **160***k*'. In accordance with some embodiments, the blocking member can be configured to engage with the expandable member to allow the clinician to distally push the expandable member while engaging a distal end of the expandable member and/or to withdraw the expandable member while engaging a proximal end of the expandable member. Thus, the expandable member can be moved without axially compressing the expandable member, which could cause the expandable member to invert or become jammed inside of the stent lumen.

As noted herein, in some embodiments, the presence of one or more blocking members can allow the clinician to push and/or pull the core wire until the one or more blocking members interacts with an end of the expandable member, whereupon further pushing or pulling of the core wire allows the clinician to impart a pushing or pulling force on the expandable member. In such embodiments, with the interaction between the blocking member(s) and the expandable member, the system can be configured such that stent foreshortening during stent expansion does not force the expandable member distally beyond the stent distal end.

In accordance with an aspect of some embodiments is the realization that after the stent distal end is initially "landed" and contacts the vessel wall, subsequently expanded sections of the stent will axially foreshorten, thus causing the overall stent to axially foreshorten and draw or advance the unexpanded stent proximal end in a distal direction. While the unexpanded stent proximal end advances distally, the core wire will tend to also advance distally relative to the stent distal end. Thus, in some embodiments, in order to prevent the expandable member from being forced distally beyond the stent distal end, the system can be configured such that blocking members positioned along the core wire do not engage with the stent proximal end or the stent distal end to push the expandable member distally beyond the stent distal end during expansion of the stent.

For example, as noted above in FIG. **4**, in some embodiments, the expandable member **54***k* can move axially along the core wire **59***k*, constrained by the interaction between the proximal end **58***ak* and the fixed blocking members **160***k*, **160***k*', but not constrained by the interaction between the distal end **58***bk* and the fixed blocking members **160***k*, **160***k*'. In such embodiments, the fixed blocking members can be placed along the core wire **59***k* such that the expandable member **54***k* is not pushed out of the stent distal end as the core wire **59***k* advances distally during stent expansion.

Accordingly, in some embodiments, the (proximal) fixed blocking member **160***k* can be positioned along the core wire **59***k* spaced sufficiently apart from the expandable member proximal end such that the fixed blocking member **160***k* will not contact or will only insubstantially contact the proximal end **58***ak* such that any contact does not urge the expandable member **54***k* out of the stent distal end.

For example, in the pre-deployment or collapsed state of the stent delivery system, the fixed blocking member **160***k* can be proximally spaced apart from the proximal end **58***ak* of the expandable member **54***k* by a first distance. The first distance can be about equal to or greater than the distance that the core wire will advance relative to the stent distal end during stent expansion or as the stent delivery system moves to the deployed state in which the stent is fully expanded and released from the stent delivery system. The first distance can be between about 2 mm and about 60 mm. In some embodiments, the first distance can be between about 5 mm and about 40 mm. Further, in some embodiments, the first distance can be between about 10 mm and about 30 mm.

In some embodiments, the expandable member **54***k* can be positioned within the stent lumen and the fixed blocking member **160***k* can be located proximal to or outside of the stent proximal end when the stent is in the collapsed position. In such an embodiment, the fixed blocking member **160***k* can be spaced apart from the stent proximal end such that when the stent expands and the core wire **59***k* and the fixed blocking member **160***k* advance, the fixed blocking member **160***k* will not force the expandable member **54***k* distally beyond the stent distal end.

Additionally, in some embodiments wherein a distal fixed blocking member (such as fixed blocking member **160***k*') is configured to engage with the stent distal end, the distal fixed blocking member can be spaced from the stent distal end at a second distance. Similar to the first distance mentioned above, the second distance can be between about 2 mm and about 60 mm. In some embodiments, the second distance can be between about 5 mm and about 40 mm. Further, in some embodiments, the second distance can be between about 10 mm and about 30 mm. Further, in some embodiments, the distal fixed blocking member can be located proximal to the stent proximal end when the stent is in the collapsed position and can be configured such that it passes through and does not engage the stent proximal end. Furthermore, in some embodiments, the distal fixed blocking member can be located distal to the stent proximal end when the stent is in the collapsed position.

Other embodiments disclosed herein that incorporate one or more (fixed and/or movable) blocking members, such as the embodiments illustrated in FIGS. **3**B-G, can also be configured such that stent expansion does not force the expandable member distally beyond the stent distal end. In order to achieve this, a fixed blocking member(s) can be spaced at an offset that allows the fixed blocking member to be advanced distally without pushing the expandable member out of the stent distal end, as discussed similarly above with respect to the first and second distances.

In accordance with some embodiments, the blocking member(s) can be configured to engage with the expandable member to allow the clinician to distally push the expandable member while engaging a distal end of the expandable member and/or to withdraw the expandable member while engaging a proximal end of the expandable member.

For example, the embodiment illustrated in FIG. **3**E illustrates a system in which the movable blocking member **60***e* is disposed between the proximal and distal ends **58***ae*, **58***be* of the expandable member **54***e*. The movable blocking member **60***e* is sized to have an outer cross-sectional profile that is greater than the inner cross-sectional profile of the proximal and distal ends **58***ae*, **58***be*, which thereby constrains movement of the movable blocking member **60***e*. When the movable blocking member **60***e* engages with either of the fixed blocking members **160***e*, the movable blocking member **60***e* will also engage with the expandable member **54***e* upon further movement of the core wire **59***e* in a given direction.

In operation, if the core wire **59***e* is pulled in a proximal direction, the fixed blocking member **58***be* can initially contact the movable blocking member **60***e* and, upon further proximal movement of the core wire **59***e*, the movable blocking member **60***e* will contact the proximal end **58***ae* of the expandable member **54***e*. Additional proximal movement of the core wire **59***e* will thus withdraw the expandable member **54***e* in a proximal direction. As this occurs, the proximal end **58***ae* of the expandable member **54***e* may tend to (at least initially) be moved proximally away from the distal end **58***be*, thus potentially and initially somewhat elongating the expandable member **54***e*. However, the expandable member **54***e* will not tend to be jammed, inverted, or otherwise deflected from an expanded shape that can be optimal for facilitating complete stent expansion.

Additionally, if the core wire **59***e* is pushed in a distal direction, the fixed blocking member **58***ae* can initially contact the movable blocking member **60***e* and, upon further distal movement of the core wire **59***e*, the movable blocking member **60***e* will contact the distal end **58***be* of the expandable member **54***e*. Additional distal movement of the core wire **59***e* will thus "push" the expandable member **54***e* in a proximal direction. As this occurs, the distal end **58***be* of the expandable member **54***e* may tend to (at least initially) be moved distally away from the proximal end **58***ae*, thus potentially and initially somewhat elongating the expandable member **54***e*. However, the expandable member **54***e* will not tend to be jammed, inverted, or otherwise deflected from an expanded shape that can be optimal for facilitating complete stent expansion.

In some embodiments, a fixed blocking member can be coupled to a core wire and can be sized such that an outer cross-sectional profile of the fixed blocking member is greater than an inner cross-sectional profile of the lumens of the proximal and distal ends of the expandable member. Thus, an embodiment having only a single blocking member can be provided that allows the expandable member to be pushed distally while engaging the expandable member distal end and withdrawn proximally while engaging the expandable member proximal end.

Accordingly, the blocking member(s) can engage with a distal end of the expandable member to push the expandable member distally and/or can engage with a proximal end of the expandable member to withdraw the expandable member proximally. Thus, in some embodiments, the expandable member can be moved proximally or distally without axially compressing the proximal and distal ends of the expandable member, which could cause the expandable member to invert or become jammed inside of the stent lumen.

Optionally, one or more of the fixed blocking members can be formed along the core wire as a protrusion or structure of the core wire itself. However, one or more of the fixed blocking structures can also be a distinct structure that is formed separately of and coupled to the core wire in a manner that prevents at least axial movement of the fixed blocking structure along the core wire. Thus, the term "fixed" in some embodiments can refer at least to axial fixation along the core wire, while optionally permitting rotational movement of the fixed blocking structure relative to the core wire.

Optionally, the fixed blocking member and the lumen can comprise one or more surface features, such as threads, protrusions, or recesses configured such that the lumen and the fixed blocking member can interact as the lumen passes over the fixed blocking member. Further, in embodiments where the fixed blocking member and the lumen do not pass over each other, the fixed blocking member and/or the lumen can comprise structures or other features that can interact with each other to fix the rotational position of the expandable member relative to the core wire.

Accordingly, the above-noted examples provide possible configurations that can limit the proximal and/or distal movement of the expandable member relative to the core wire. Embodiments can be provided in which the movable blocking structures are omitted and the inner profiles of the lumens of the proximal and distal ends of the expandable member are configured to correspond with an outer profile or cross-section of the fixed blocking member(s).

However, some embodiments, including those illustrated and discussed above, can comprise at least one floating or movable blocking structure that can interact with a fixed blocking structure and one or both of the ends of the expandable member to limit or control axial and/or rotational movement of the expandable member. Further, the inner and/or outer "cross-section" of the lumens and members discussed herein can define any of a variety of geometric shapes or profiles.

For example, a variety of profiles can be provided that have one or more longitudinally extending slits or grooves that can provide a keyed structure so as to limit rotational movement of the expandable member relative to the core wire, but to allow axial movement of the expandable member relative to the core wire. Additionally, a variety of profiles can be provided that provide a proximal and/or distal axial travel limit while allowing rotation of the expandable member relative to the core wire.

While only three struts **54***a-c* are specifically referenced in FIG. **2** (among the six depicted therein), it will be appreciated that more or fewer than three struts **54***a-c* can be employed, without departing from the scope of the disclosure.

For example, the expandable member **54** can include between 3 and 5 struts, between 5 and 10 struts, between 10 and 15 struts, between 15 and 20 struts, or 20 or more struts. Moreover, while the expandable member **54** is characterized or otherwise depicted as an expanded tube or "onion-shaped" structure, it can equally conform to other shapes and/or configurations in order to fit particular applications. Other such shapes and/or configurations can include an ellipsoid of revolution, a prolate spheroid, etc.

The core assembly **57** can further include a distal stent cover **71** configured to act as a bearing or reduce friction between the stent **66** (e.g., the distal portion or distal end **67** thereof) and the inner surface **17** of the catheter **8**. As shown in the embodiment in FIG. **2**, the core assembly **57** can be configured such that the distal stent cover **71** extends adjacent to or at least partially axially over the expandable member **54**.

In some embodiments, the expandable member can be positioned along the distal end of the core assembly **57**. The expandable member **54** is shown in FIG. **2** as being axially positioned adjacent to the distal end **67** of the stent **66**. In particular, the expandable member **54** can be positioned inside of the distal end **67** of the stent **66** and inside of the proximal portion of the distal stent cover **71**. Further, the expandable member **54** can extend beyond the distal end **67** of the stent **66** and into a space defined by the proximally extending proximal portion of the distal stent cover **71**.

In some embodiments, the expandable member can be positioned along the proximal end of the core assembly **57**. The expandable member can also be positioned between the proximal and distal ends of the core assembly. For example, the expandable member can be positioned between the proximal and distal ends **68**, **67** of the stent **66**. Further, in embodiments wherein two or more expandable members are used, each can be positioned at or between the proximal and distal ends of the core assembly.

The distal stent cover **71** can be made of a lubricious and/or hydrophilic material. In some embodiments, the distal stent cover **71** can be made of polytetrafluoroethylene, better known as TEFLON®, but can be made from other lubricious materials known by those skilled in the art, without departing from the scope of the disclosure. The distal stent cover can include a proximal portion **71***a* and a distal portion **71***b*. In some embodiments, the distal portion **71***b* of the distal stent cover **71** can be coupled to the tip coil **61** using, for example, a shrink tube **73** configured to shrink and capture a distal end of the distal stent cover **71** against the tip coil **61**. In other embodiments, the distal portion **71***b* of the distal stent cover **71** is coupled to the tip coil **61** via other devices or attachment means, including, but not limited to mechanical fasteners, welding techniques, adhesives, heat bonding, combinations thereof, or the like. In yet other embodiments, the distal stent cover **71** (i.e., the distal portion **71***b*) is coupled or otherwise attached directly to the distal portion **53***b* of the core wire **59** itself using one or more of the devices or attachment means discussed herein.

The distal stent cover **71** can be manufactured or otherwise cut from a tube of the material selected for the distal stent cover **71**. In some embodiments, the proximal portion **71***a* can be formed as strips cut from the tube, and the distal portion **71***b* can be an uncut length of the tube. Accordingly, the tubular distal portion **71***b* and the proximally extending strips of the proximal portion **71***a* can form a single, integral device or structure. The distal stent cover **71** can be a generally cylindrical or tubular structure formed by one or more strips or flaps of material coupled to the distal tip portion. For example, the distal stent cover **71** can be attached to the tip coil **61**. In some embodiments, the tubular distal portion **71***b* can be shrunk onto or otherwise coupled to the tip coil **61** using mechanical fasteners, welding techniques, adhesives, heat bonding, combinations thereof, or the like, and the shrink tube **73** can be used, as described above. In yet other embodiments, the shrink tube **73** alone can be coupled to the tubular distal portion **71***b* to the tip coil **61**.

The distal stent cover **71** can comprise a tube wherein the proximal portion **71***a* includes two or more semi-cylindrical or partially cylindrical strips or tube portions separated by a corresponding number of generally parallel, longitudinally oriented cuts or separations formed or otherwise defined in the sidewall of the tube. Therefore, when in the pre-deployment state, as shown in FIGS. **2**-**3**, the proximal portion **71***a* can generally have the shape of a longitudinally split or longitudinally slotted tube interposed between the outer surface **40***b* of the stent **66** and the inner surface **17** of the catheter **8**. The strips of the proximal portion **71***a* can collectively span substantially the entire circumference of the outer surface **40***b* of the stent **66** (e.g., where the cuts between the strips are splits of substantially zero width), or somewhat less than the entire circumference (e.g., where the cuts between the strips are slots having significant width). The strips of the proximal portion **71***a* can be of substantially uniform size; e.g., two strips spanning approximately 180 degrees each, three strips of approximately 120 degrees each, four strips of approximately 90 degrees each, etc. Alternatively, the strips can differ in angular sizing, without departing from the scope of the disclosure. In some embodiments, only two strips or tube portions are employed in the proximal portion **71***a*. The use of two strips facilitates fold-over or everting of the distal stent cover **71**, as discussed in more detail below, while minimizing the number of free or uncontained strips in the blood vessel lumen and any potential for injuring the vessel by virtue of contact between a strip and the vessel wall.

At or near the distal end **67** of the stent **66**, the proximal portion **71***a* of the distal stent cover **71** can be inverted or otherwise folded within itself, thereby creating a folded region **74** interposed between the outer surface **40***b* of the stent **66** and the inner surface **17** of the catheter **8**. As illustrated, the folded region **74** defines an outer layer **74***a* and an inner layer **74***b*, where the outer layer **74***a* is adjacent the inner surface **17** of the catheter **8** and the inner layer **74***b* is adjacent the outer surface **40***b* of the stent **66**. In some embodiments, the distal stent cover **71** can be configured to fold over itself, in a manner opposite to that shown in FIG. **3**A, such that layer **74***a* would be the inner layer and layer **74***b* would be the outer layer. In other embodiments, the proximal portion **71***a* is not folded, inverted, or everted at all, when in the pre-deployment configuration.

In operation, the distal stent cover **71**, and in particular the folded region **74**, generally covers and protects the distal end **67** of the stent **66** as the stent **66** is axially translated within the catheter **8**. The distal stent cover **71** can serve as a bearing or buffer layer that, for example, prevents the filament ends **99** of the stent **66** from contacting the inner surface **17** of the catheter **8**, which could damage the stent **66** and/or catheter **8**, or otherwise compromise the structural integrity of the stent **66**. In some embodiments, ends of the folded region **74** can be inverted within the distal stent cover **71**, such that the end of the distal stent cover **71** forms the inner layer/surface between the outer surface of the stent **66** and the distal stent cover **71**. This can permit distal advancement of the core wire assembly through the catheter **8**, while engaging the inner surface of the catheter **8**, without unfurling. Since the distal stent cover **71** can be made of a lubricious material, the distal stent cover **71** can exhibit a low coefficient of friction that allows the distal end **67** of the stent **66** to translate or slide within the catheter **8** with relative ease. For example, the distal stent cover **71** can have a coefficient of friction of between about 0.02 and about 0.2. In some embodiments, the distal stent cover **71** can have a coefficient of friction of about 0.04. Accordingly, the distal stent cover **71** may be configured to provide a lubricious interface between the outer surface **40***b* of the stent **66** and the inner surface **17** of the catheter **8**.

Referring generally to FIGS. **2**-**8**, operation of a stent delivery system **5** is illustrated in accordance with aspects of some embodiments. Operation of some embodiments can be performed such that the catheter **8** is percutaneously introduced into a blood vessel **69** and advanced to a treatment site in the blood vessel **69**, such as the site of an aneurysm (not shown). In some embodiments, the catheter **8** is guided to the treatment site using fluoroscopic imaging, in which one or more radiopaque markers (not shown) located on the distal portion **18***b* of the catheter **8** indicate a position of the catheter **8** in a fluoroscopic image. The catheter **8** can also be guided using other imaging techniques including, but not limited to, ultrasound and magnetic resonance imaging.

Additionally or alternatively, in some embodiments, the expandable member can comprise one or more radiopaque materials or portions to facilitate fluoroscopic imaging of the stent delivery system. For example, the expandable member can be fabricated from a radiopaque material or comprise one or more markers located on the proximal or distal ends thereof.

Once the catheter **8** is positioned at the treatment site **53**, the core assembly **57** can be introduced into the catheter **8** and advanced distally toward the distal opening **19**. FIGS. **2**-**3** depict the stent delivery system **5** with the stent **66**, expandable member **54**, and distal stent cover **71** in a pre-deployment configuration. While in this configuration, the stent **66**, expandable member **54**, and distal stent cover **71** can be advanced distally within the catheter **8** from a starting location (e.g., in a proximal portion of the catheter **8**, which can be outside of the body of the patient) to a location within the distal portion of the catheter **8**, at or near the distal end **18***b* thereof. This advancement can be achieved by applying a distally directed force to the core wire **59**, which force can be transmitted to the stent **66** via the bumpers(s) **62**. As the stent **66**, expandable member **54**, and distal stent cover **71** are so advanced, the proximal portion **71***a* of the distal stent cover **71** remains interposed between the outer surface **40***b* and/or distal end **67** of the stent **66** and the inner surface **17** of the catheter **8**. Thus, the distal stent cover **71** can prevent the distal end **67** of the advancing stent **66** (e.g., the filament ends **99** thereof) from damaging, abrading, or gouging the catheter **8**, and from thereby impeding progress of the stent **66** along the catheter **8**. This can, in turn, prevent damage to the stent **66** such as by longitudinal compression resulting from high friction generated between the distal end **67** and the catheter **8** while distally directed force is applied to the proximal portions of the stent **66**.

The distal end **67** of the stent **66** can be advanced beyond the distal portion **18***b* of the catheter **8** while the proximal end **68** of the stent **66** remains compressed within the catheter **8**. As the distal end **67** of the stent **66** exits the distal opening **19**, it can automatically expand, be expanded manually, or self-expand to an expanded configuration. In its expanded configuration, the outer surface **40***b* of the stent **66** can be "landed" or extend to and preferably lie mostly or completely adjacent to the inner surface **55** of the blood vessel **69**. Thereafter, the stent **66** can be fully deployed at the site or resheathed and repositioned, if necessary.

During deployment, the stent **66** can contract axially as it expands radially within the blood vessel. In some embodiments, the axial foreshortening of both the stent **66** and the expandable member **54**, and their respective radial expansions, can cause the strips or tube portions of the proximal portion **71***a* (FIG. **3**A) of the distal stent cover **71** to separate and move radially outward, disengaging from contact with the stent **66**. In one or more embodiments, as the distal stent cover **71** moves and/or disengages from the stent, it unfurls or otherwise unravels from its folded configuration (FIG. **3**A). Once the distal stent cover **71** withdraws or otherwise unravels, it may no longer cover the distal end **67** of the stent **66**. Instead, the distal stent cover **71** may be left coupled to the tip coil **61** and its free ends may be generally unconstrained within the blood vessel **69**.

In some embodiments, such as shown in FIG. **8**, if the distal stent cover **71** has unfurled, the distal stent cover **71** can be configured to entirely invert or fold back over itself as the wire **59** is drawn proximally. Thus, the distal stent cover **71** can be flexible and be able to be proximally withdrawn into the catheter to allow the core assembly (including the stent) to be resheathed or removed through the catheter. Thus, this can prove beneficial when the core assembly is withdrawn into the catheter after the stent has been deployed, which can allow for another core assembly (with an additional stent) to be introduced through the catheter to permit "telescoping" or placement of multiple stents without having to remove the catheter. As can also be appreciated, the flexibility of the distal stent cover **71** can also prove beneficial when the initial deployment site of the stent **66** is incorrect or otherwise has to be relocated to properly cover the treatment site of interest. Accordingly, in some embodiments, the stent **66** can be partially deployed, resheathed, and relocated multiple times as needed in order to ensure that the stent **66** is properly deployed in the correct location for best use.

For example, referring to FIG. **6**, after initially "landing" the stent **66** in the blood vessel, in order to deploy the remaining portions of the stent **66** in the blood vessel **69**, the catheter **8** can be retracted further proximally relative to the stent **66**. As the catheter **8** is retracted, the released portions of the stent **66** can be expanded (automatically or manually) to contact the inner surface **55** of the blood vessel **69**. In some embodiments, before the stent **66** is fully deployed into the blood vessel **69**, and before the stent bumper(s) **62** has passed distally out of the catheter **8**, the stent **66** can be retracted or otherwise resheathed back into the catheter **8**. As the core wire **59** is retracted proximally, the one or more stent bumpers **62**, which can still be in contact with, urged, or biased against the inner surface **40***a* of the stent **66**, can grip the stent **66** to facilitate moving it proximally and back into its compressed configuration within the catheter **8**.

For example, to resheath the core assembly **57** within the catheter **8**, the core wire **59** can be pulled proximally while the catheter **8** remains stationary. As the core wire **59** moves proximally, if the core assembly **57** has any stent bumpers **62**, they can be reintroduced into the catheter **8**. Once the expandable member **54** reaches the distal opening **19**, the struts **54***a-c* contact the distal portion **18***b* of the catheter **8** and are thereby forced back into their compressed configurations. As discussed above, the proximal and/or distal ends **58***a*, **58***b* can be freely axially movable along the core wire **59**. Thus, the proximal and/or distal ends **58***a*, **58***b* can translate proximally and/or distally along the core wire **59** to facilitate compression or contraction of the expandable member **54**. Specifically, in some embodiments, if the proximal end **58***a* is fixed relative to the core wire **59**, the contact between the expandable member **54** and the catheter **8** can force the distal end **58***b* of the expandable member **54** to slide distally along the core wire **59** and thereby axially elongate and collapse or compact the expandable member **54** for reinsertion in the catheter **8**.

In some embodiments, the expandable member **54** can facilitate the initial expansion and/or the subsequent or final expansion of the stent. For example, the expandable member can facilitate the initial expansion when the distal end of the stent is "landed" at the desired location. Further, after the stent is completely released from the core assembly, the expandable member can be used to urge partially expanded portions of the stent towards a fully expanded configuration by engaging the inner surface of the stent.

As discussed herein, in some embodiments, after the expandable member has exited the catheter, the expandable member can move from the collapsed position toward the expanded position. For example, the distal end and the proximal end of the expandable member can converge toward each other which allows the struts to expand radially. As discussed herein, some embodiments of the expandable member can comprise resilient struts or configuration that causes the expandable member to move to a radially expanded shape when outside of the catheter **8**. In some embodiments, one or both of the proximal and distal ends **58***a*, **58***b* of the members **54***a-c* of the expanding member **54** can slide or otherwise translate along the core wire **59** to facilitate radial expansion of the expanding member **54**. In embodiments wherein the proximal end **58***a* is fixed, the distal end **58***b* can contract proximally (i.e., converge axially toward the fixed proximal end **58***a*). These movements can cause the expandable member **54** to be axially contracted or foreshortened and radially expanded.

After the expandable member has expanded and/or while it expands, the expandable member **54** can cause at least a portion of the stent **66** to expand. For example, the expandable member **54** can cause at least a portion of the stent **66** to expand by expanding and engaging the inner surface of the stent **66**. For example, if the expandable member is positioned adjacent to the distal end of the stent, the expandable member can facilitate expansion of the distal end of the stent to "land" the stent in the vessel. The expandable member can be used to help achieve consistent results of the system and provide full initial expansion of the stent within the blood vessel. For example, as the expandable member **54** exits the distal opening **19** of the catheter **8** along with the stent **66** during deployment, it can expand automatically, be expanded manually, or self-expand to its natural, expanded configuration. According to some embodiments, the struts can be configured such that spring forces in each of the struts **54***a-c* can tend to facilitate to the expansion of the distal end **67** of the stent **66**. Accordingly, the expandable member **54** can facilitate a more complete initial expansion of the distal end **67** of the stent **66** into apposition with the vessel, thereby assisting in the initial anchoring of the distal end **67** of the stent **66**. This also results in better wall apposition, such that an increased amount of friction is generated against the inner surface **55** of the blood vessel **69** by the stent **66**. In some embodiments, increasing the friction force between the blood vessel **69** and the stent **66** can allow the user to strategically expand the remaining portions of the stent **66**. Further, other portions of the stent (e.g., central portions, proximal portion, etc.) can be initially expanded using an expandable member. As noted above, more than one expandable member can be used in some embodiments, which can be employed to facilitate initial and/or subsequent or final expansion of the stent.

The expandable member can facilitate not only initial expansion upon deployment, but can also be passed along the lumen of the deployed stent to force open portions of the stent that may not have deployed fully. Thus, subsequent to the initial deployment, unsheathing, or release of the stent from the core wire, the expandable member can be passed axially along the lumen of the stent to tend to urge open any portions of the stent that did not expand into apposition with the walls of the vessel.

For example, referring to the embodiment in FIG. **7**, once the stent **66** is fully deployed within the blood vessel **69**, the expandable member **54** can be used to ensure that every portion of the stent **66** is fully engaged with the inner surface **55** of the blood vessel **69**. In some embodiments, the stent **66** can provide structural support to the vessel wall **55** to strengthen the blood vessel **69** and prevent or reduce the likelihood of reclosure. In some embodiments, the expandable member **54** can be translated axially back and forth within the deployed stent **66**, continuously urging or biasing the inner surface **40***a* of the stent **66**, such as in the use of a mandrel-type device. Using the radial spring force of the expandable member **54**, any sagging or unapposed portions of the stent **66** can be pressed or forced into proper engagement with the blood vessel **69** as the expandable member **54** translates along the lumen of the stent **66**.

Referring to FIGS. **7** and **8**, after the stent **66** is fully deployed in the blood vessel **69**, the catheter **8** and core assembly **57** can be withdrawn from the blood vessel **69** or otherwise retracted out of the vasculature of the patient. In some embodiments, the catheter **8** and the core assembly **57** can be removed separately from the blood vessel **69**. In other embodiments, however, the core assembly **57** can be resheathed back into the catheter **8** and removed with the catheter **8**. As also noted, the core assembly **57** can be easily withdrawn through the catheter **8** by itself (with the catheter **8** remaining in place) after stent deployment to facilitate "telescoping" or to reduce overall rigidity of the catheter assembly, such that the catheter can be more flexible when being withdrawn from the vessel.

The apparatus and methods discussed herein are not limited to the deployment and use of an occluding device within any particular vessels, but can include any number of different types of vessels. For example, in some aspects, vessels can include arteries or veins. In some aspects, the vessels can be suprathoracic vessels (e.g., vessels in the neck or above), intrathoracic vessels (e.g., vessels in the thorax), subthoracic vessels (e.g., vessels in the abdominal area or below), lateral thoracic vessels (e.g., vessels to the sides of the thorax such as vessels in the shoulder area and beyond), or other types of vessels and/or branches thereof.

In some aspects, the stent delivery systems disclosed herein can be deployed within superthoracic vessels. The suprathoracic vessels can comprise at least one of intracranial vessels, cerebral arteries, and/or any branches thereof. For example, the suprathoracic vessels can comprise at least one of a common carotid artery, an internal carotid artery, an external carotid artery, a middle meningeal artery, superficial temporal arteries, an occipital artery, a lacrimal (ophthalmic) artery, an accessory meningeal artery, an anterior ethmoidal artery, a posterior ethmoidal artery, a maxillary artery, a posterior auricular artery, an ascending pharyngeal artery, a vertebral artery, a left middle meningeal artery, a posterior cerebral artery, a superior cerebellar artery, a basilar artery, a left internal acoustic (labyrinthine) artery, an anterior inferior cerebellar artery, a left ascending pharyngeal artery, a posterior inferior cerebellar artery, a deep cervical artery, a highest intercostal artery, a costocervical trunk, a subclavian artery, a middle cerebral artery, an anterior cerebral artery, an anterior communicating artery, an ophthalmic artery, a posterior communicating artery, a facial artery, a lingual artery, a superior laryngeal artery, a superior thyroid artery, an ascending cervical artery, an inferior thyroid artery, a thyrocervical trunk, an internal thoracic artery, and/or any branches thereof. The suprathoracic vessels can also comprise at least one of a medial orbitofrontal artery, a recurrent artery (of Heubner), medial and lateral lenticulostriate arteries, a lateral orbitofrontal artery, an ascending frontal (candelabra) artery, an anterior choroidal artery, pontine arteries, an internal acoustic (labyrinthine) artery, an anterior spinal artery, a posterior spinal artery, a posterior medial choroidal artery, a posterior lateral choroidal artery, and/or branches thereof. The suprathoracic vessels can also comprise at least one of perforating arteries, a hypothalamic artery, lenticulostriate arteries, a superior hypophyseal artery, an inferior hypophyseal artery, an anterior thalamostriate artery, a posterior thalamostriate artery, and/or branches thereof. The suprathoracic vessels can also comprise at least one of a precentral (pre-Rolandic) and central (Rolandic) arteries, anterior and posterior parietal arteries, an angular artery, temporal arteries (anterior, middle and posterior), a paracentral artery, a pericallosal artery, a callosomarginal artery, a frontopolar artery, a precuneal artery, a parietooccipital artery, a calcarine artery, an inferior vermian artery, and/or branches thereof.

In some aspects, the suprathoracic vessels can also comprise at least one of diploic veins, an emissary vein, a cerebral vein, a middle meningeal vein, superficial temporal veins, a frontal diploic vein, an anterior temporal diploic vein, a parietal emissary vein, a posterior temporal diploic vein, an occipital emissary vein, an occipital diploic vein, a mastoid emissary vein, a superior cerebral vein, efferent hypophyseal veins, infundibulum (pituitary stalk) and long hypophyseal portal veins, and/or branches thereof.

The intrathoracic vessels can comprise the aorta or branches thereof. For example, the intrathoracic vessels can comprise at least one of an ascending aorta, a descending aorta, an arch of the aorta, and/or branches thereof. The descending aorta can comprise at least one of a thoracic aorta, an abdominal aorta, and/or any branches thereof. The intrathoracic vessels can also comprise at least one of a subclavian artery, an internal thoracic artery, a pericardiacophrenic artery, a right pulmonary artery, a right coronary artery, a brachiocephalic trunk, a pulmonary trunk, a left pulmonary artery, an anterior interventricular artery, and/or branches thereof. The intrathoracic vessels can also comprise at least one of an inferior thyroid artery, a thyrocervical trunk, a vertebral artery, a right bronchial artery, a superior left bronchial artery, an inferior left bronchial artery, aortic esophageal arteries, and/or branches thereof.

In some aspects, the intrathoracic vessels can also comprise at least one of a right internal jugular vein, a right brachiocephalic vein, a subclavian vein, an internal thoracic vein, a pericardiacophrenic vein, a superior vena cava, a right superior pulmonary vein, a left brachiocephalic vein, a left internal jugular vein, a left superior pulmonary vein, an inferior thyroid vein, an external jugular vein, a vertebral vein, a right highest intercostal vein, a 6th right intercostal vein, an azygos vein, an inferior vena cava, a left highest intercostal vein, an accessory hemiazygos vein, a hemiazygos vein, and/or branches thereof.

In some aspects, the subthoracic vessels can comprise at least one of renal arteries, inferior phrenic arteries, a celiac trunk with common hepatic, left gastric and splenic arteries, superior suprarenal arteries, a middle suprarenal artery, an inferior suprarenal artery, a right renal artery, a subcostal artery, 1st to 4th right lumbar arteries, common iliac arteries, an iliolumbar artery, an internal iliac artery, lateral sacral arteries, an external iliac artery, a testicular (ovarian) artery, an ascending branch of deep circumclex iliac artery, a superficial circumflex iliac artery, an inferior epigastric artery, a superficial epigastric artery, a femoral artery, a ductus deferens and testicular artery, a superficial external pudendal artery, a deep external pudendal artery, and/or branches thereof. The subthoracic vessels can also comprise at least one of a superior mesenteric artery, a left renal artery, an abdominal aorta, an inferior mesenteric artery, colic arteries, sigmoid arteries, a superior rectal artery, 5th lumbar arteries, a middle sacral artery, a superior gluteal artery, umbilical and superior vesical arteries, an obturator artery, an inferior vesical and artery to ductus deferens, a middle rectal artery, an internal pudendal artery, an inferior gluteal artery, a cremasteric, pubic (obturator anastomotic) branches of inferior epigastric artery, a left colic artery, rectal arteries, and/or branches thereof.

In some aspects, the lateral thoracic vessels can comprise at least one of humeral arteries, a transverse cervical artery, a suprascapular artery, a dorsal scapular artery, and/or branches thereof. The lateral thoracic vessels can also comprise at least one of an anterior circumflex humeral artery, a posterior circumflex humeral artery, a subscapular artery, a circumflex scapular artery, a brachial artery, a thoracodorsal artery, a lateral thoracic artery, an inferior thyroid artery, a thyrocervical trunk, a subclavian artery, a superior thoracic artery, a thoracoacromial artery, and/or branches thereof.

In some embodiments, a catheter, such as that described in U.S. patent application Ser. No. 12/731,110, which was filed on Mar. 24, 2010, and which incorporated herein by reference in its entirety, can be used to deliver a stent delivery system. The delivery system can include an expandable occluding device (e.g., stent) configured to be placed across an aneurysm that is delivered through the distal portion of the catheter, out a distal tip, and into the vasculature adjacent an aneurysm in, for example, the middle cerebral artery. A proximal portion of the catheter can remain partially or entirely within a guiding catheter during delivery, and an intermediate portion, taper portion, and distal portion of the catheter can extend distally of the guiding catheter. The occluding device can be released at the target location and can be used to occlude blood flow into the aneurysm. The catheter can be used to reach target locations (e.g., aneurysms) located elsewhere in the body as well, include but not limited to other arteries, branches, and blood vessels such as those described above.

The apparatus and methods discussed herein are not limited to the deployment and use of an occluding device or stent within the vascular system but can include any number of further treatment applications. Other treatment sites can include areas or regions of the body such as organ bodies. Modification of each of the above-described apparatus and methods for carrying out the subject technology, and variations of aspects of the disclosure that are apparent to those of skill in the art are intended to be within the scope of the claims. Furthermore, no element, component, or method step is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims.

Although the detailed description contains many specifics, these should not be construed as limiting the scope of the subject technology but merely as illustrating different examples and aspects of the subject technology. It should be appreciated that the scope of the subject technology includes other embodiments not discussed in detail above. Various other modifications, changes and variations which will be apparent to those skilled in the art can be made in the arrangement, operation and details of the method and apparatus of the subject technology disclosed herein without departing from the spirit and scope of the subject technology as defined in the appended claims. Therefore, the scope of the subject technology should be determined by the appended claims and their legal equivalents. Furthermore, no element, component or method step is intended to be dedicated to the public regardless of whether the element, component or method step is explicitly recited in the claims. Underlined and/or italicized headings and subheadings are used for convenience only, do not limit the subject technology, and are not referred to in connection with the interpretation of the description of the subject technology. In the claims and description, unless otherwise expressed, reference to an element in the singular is not intended to mean "one and only one" unless explicitly stated, but rather is meant to mean "one or more." In addition, it is not necessary for a device or method to address every problem that is solvable by different embodiments of the disclosure in order to be encompassed by the claims.

What is claimed is:

1. A stent delivery system, comprising:

an elongate body having a lumen extending from a proximal portion to a distal portion of the body, the distal portion being configured to extend within a blood vessel;

a stent expandable from a compressed configuration, sized to be received within the elongate body lumen, to an expanded configuration, the stent having a lumen and an inner surface extending from a proximal end to a distal end of the stent;

a core wire configured to extend through the elongate body lumen and the stent lumen and having a distal region;

a distal stent cover extending proximally from the distal region of the core wire and interposed between an outer surface of the stent and an inner surface of the elongate body;

a self-expanding member disposed along the core wire distal region, the self-expanding member comprising first and second end portions, the first and second end portions each comprising lumens through which the core wire passes to enable the self-expanding member to be rotatably and slidably movable relative to the core wire, the self-expanding member being configured to facilitate the expansion of at least a portion of the stent to the expanded configuration by expanding and engaging the stent inner surface; and

a fixed blocking member fixed to the core wire between the first and second end portions of the self-expanding member, the fixed blocking member having an outer cross-sectional profile greater than inner cross-sectional profiles of the apertures of the first and second end portions of the self-expanding member to limit axial movement of the first and second end portions along the core member upon contact with the fixed blocking member.

2. The system of claim **1**, further comprising a movable blocking member being slidable along the core wire relative to the fixed blocking member, the fixed blocking member defining an outer cross-sectional profile that is sized greater than an inner cross-sectional profile of a lumen of the movable blocking member, the movable blocking member defining an outer cross-sectional profile that is sized greater than an inner cross-sectional profile of a lumen of the first end portion of the self-expanding member, the movable blocking member being disposed between the first end portion of the self-expanding member and the fixed blocking member, such that the first end portion of the self-expanding member is blocked from sliding past the movable blocking member and the fixed blocking member.

3. The system of claim **1**, further comprising a movable blocking member.

4. The system of claim **1**, further comprising a second fixed blocking member and a movable blocking member.

5. The system of claim **1**, wherein the self-expanding member comprises a plurality of filaments.

6. The system of claim **1**, wherein the self-expanding member comprises a shape memory material.

7. The system of claim **1**, wherein the self-expanding member self-expands when radially unrestrained by the elongate body.

8. The system of claim **1**, wherein the distal stent cover comprises a folded region having (a) an outer layer configured to be urged against the inner surface of the elongate body and (b) an inner layer configured to contact the outer surface of the stent.

9. The system of claim **8**, wherein the folded region is an inverted section of the distal stent cover where the distal stent cover folds within itself.

10. The system of claim **1**, wherein the distal stent cover is coupled to the core wire.

11. The system of claim **1**, wherein the distal stent cover is formed by one or more flaps of material.

12. The system of claim **1**, wherein the distal stent cover comprises a lubricious material.

13. A stent delivery system, comprising:

a core wire having a distal region;

a distal stent cover extending proximally from the distal region of the core wire, the distal stent cover configured to be disposed over an outer surface of a stent;

a self-expanding member disposed along the core wire distal region, the self-expanding member comprising first and second end portions that are each axially slidable along the core wire, wherein the self-expanding member can expand from a collapsed configuration to an expanded configuration upon axial convergence of the first and second end portions;

a fixed blocking member coupled to the core wire between the first and second end portions of the self-expanding member, the fixed blocking member limiting axial movement of the self-expanding member along the core member upon contact with the fixed blocking member; and

an elongate body having proximal and distal portions and a lumen extending between the proximal and distal portions, wherein the core wire extends within the elongate body lumen.

14. The system of claim **13**, wherein the blocking member limits axial movement of both the first and second end portions along the core member.

15. The system of claim **13**, further comprising a movable blocking member being slidable along the core wire relative to the fixed blocking member.

16. The system of claim **15**, wherein the movable blocking member comprises a lumen having an inner cross-sectional profile that is sized less than an outer cross-sectional profile of the fixed blocking member, the fixed blocking member limiting movement of the movable blocking member along the core wire.

17. The system of claim **16**, wherein the first and second end portions each comprise a lumen, wherein the first end portion lumen has a first inner cross-sectional profile greater than a second inner cross-sectional profile of the second end portion lumen and the outer cross-sectional profile of the fixed blocking member, and wherein the movable blocking member comprises an outer cross sectional profile greater than the first inner cross-sectional profile to limit movement of the first end portion relative to the fixed blocking member.

18. The system of claim **13**, wherein the first and second end portions each comprise a lumen, wherein the first end portion lumen has a first inner cross-sectional profile greater than a second inner cross-sectional profile of the second end portion lumen and an outer cross-sectional profile of the fixed blocking member.

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